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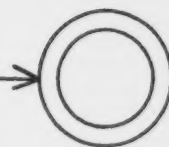
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ABSTRACT

This issue includes the following articles: "On Negative Alternative Questions" (Chung-hye Han); "A Categorical Syntax for Verbs of Perception" (Robin Clark, Gerhard Jager); "Defective Complements in Tree Adjoining Grammar" (Seth Kulick, Robert Frank, K. Vijayshanker); "The Convergence of Lexicalist Perspectives in Psycholinguistics and Computational Linguistics" (Albert E. Kim, Bangalore Srinivas, John C. Trueswell); "Event Heads and the Distribution of Psych-Roots" (Martha McGinnis); "Echo Reduplication in Kannada: Implications for a Theory of Word Formation" (Jeffrey Lidz); "The Distribution of the Old Irish Infixes Pronouns: Evidence for the Syntactic Evolution of Insular Celtic?" (Ronald Kim); "Discourse Salience and Pronoun Resolution in Hindi" (Rashmi Prasad, Michael Strube); "The Effect of Thematic Roles on Pronoun Use and Frequency of Reference Continuation" (Jennifer E. Arnold); "Bilingual Code-Switching and the Open/Closed Class Distinction" (Ellen F. Prince and Susan Pintzuk); "Dialect Acquisition and Prestige" (Clarissa Surek-Clark); "Final Extrametricality in Latin and Manam" (Eugene Buckley); "Yoruba Vowel Elision and Compounding" (Amanda Seidl); "The Laryngeal Effect in Korean: Phonology or Phonetics?" (Eon-Suk Ko); and "Multidimensional Exploration of Online Linguistic Field Data" (Steven Bird). Individual articles contain references. (KFT)

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On Negative Alternative Questions*

Chung-hye Han

1 Introduction

The question in (1) is formally a *yes-no* question. But in terms of its interpretation, it is ambiguous: it can have either a *yes-no* question reading or an alternative question reading.

- (1) Did John drink coffee or tea?

Under the *yes-no* question reading, the speaker has no presupposition as to whether John drank coffee or tea, and the possible answers are *Yes, John drank coffee or tea* and *No, John didn't drink coffee or tea*. Under the alternative question reading, the speaker presupposes that John drank either coffee or tea, and the possible answers are *John drank coffee* and *John drank tea*.

The corresponding negative *yes-no* question can be formed in two ways: with *n't* as in (2a), and with *not* as in (2b). I will refer to the negative *yes-no* questions formed with *n't* as *n't-questions* and the ones formed with *not* as *not-questions*.

- (2) a. Didn't John drink coffee or tea?
b. Did John not drink coffee or tea?

Although the questions in (2a) and (2b) have the same components, namely the proposition *John drank coffee or tea* and negation, they do not have the exact same interpretation. The question in (2b) has both the *yes-no* question reading and the alternative question reading available. Under the *yes-no* question reading, the possible answers are *Yes, John drank coffee or tea* and *No, John did not drink coffee or tea*. Under the alternative question reading, the speaker presupposes that among coffee and tea, there is a drink that John didn't drink, and the possible answers are *John did not drink coffee* and *John did not drink tea*. On the other hand, the question in (2a) only has the *yes-no* question reading available.

In this paper, I show that the (un)availability of the alternative question reading in negative *yes-no* questions such as (2) is a puzzle given the syntax

*I am indebted to Maribel Romero for extensive discussions on this topic. I also thank the participants in the semantics of questions seminar in Spring 1999 for discussions and comments: Cassandre Creswell, Alexis Dimitriadis, Narae Han, and Alexander Williams. I also acknowledge the anonymous reviewer for very helpful comments.

of *yes-no* questions and the syntax of disjunction proposed in Larson (1985). In section 2, I briefly discuss Larson's analysis of affirmative alternative questions and extend it to negative alternative questions. It will turn out that although Larson makes correct predictions for *n't*-questions, he does not do so for *not*-questions. In sections 3 and 4, I consider two alternative syntactic approaches that may explain the problem at hand. In section 3, I modify Larson's (1985) analysis to include LF movement of the disjunctive phrase and in section 4, I extend Schwarz's (1999) gapping analysis on *either...or* constructions to *whether...or* constructions. However, I will point out problems for both approaches; neither can explain the interpretive asymmetry between *n't*-questions and *not*-questions. In section 5, I pursue a non-syntactic approach and suggest that (un)availability of the alternative question reading in negative *yes-no* questions should be explained by the interaction between the syntax and the interpretive component of the grammar.

2 Larson (1985)

2.1 On Affirmative Questions

According to Larson (1985), a *yes-no* question has an empty operator that corresponds to *whether*. It originates from a disjunction phrase and moves to [Spec, CP], marking the scope of disjunction. Moreover, a *yes-no* question may have an unpronounced disjunction phrase *or not*. If the disjunction phrase from which the empty *whether* originates is the unpronounced *or not*, then the *yes-no* question reading is derived. Otherwise, the alternative question reading is derived. For instance, the *yes-no* question in (1) (repeated below as (3)) can have either a *yes-no* question reading or an alternative question reading. Under the *yes-no* question reading, the empty *whether* operator originates from the unpronounced *or not* and moves to [Spec, CP], as represented in (3a). This representation makes available the alternatives *John drank coffee or tea* and *John didn't drink coffee or tea* as answers. Under the alternative question reading, the empty operator originates from the disjunction phrase *coffee or tea* and moves to [Spec, CP], as represented in (3b). This representation makes available the alternatives *John drank coffee* and *John drank tea* as answers.

- (3) Did John drink coffee or tea?
- a. *yes-no* question:
 $Op_i (\epsilon_i \text{ or not}) [\text{did John drink [coffee or tea]}]$
 $\{\text{John drank coffee or tea, John didn't drink coffee or tea}\}$
 - b. *alternative* question:
 $Op_i [\text{did John drink } [\epsilon_i \text{ coffee or tea}]]$
 $\{\text{John drank coffee, John drank tea}\}$

Supporting evidence for the proposal that empty *whether* moves from a disjunction phrase to [Spec, CP] comes from the fact that *yes-no* questions that have a disjunction phrase inside an island do not have the alternative question reading available.

- (4) Do you believe the claim that Bill resigned or retired?
- a. *yes-no* question:
 $Op_i (\epsilon_i \text{ or not}) [\text{do you believe } [NP \text{ the claim that Bill resigned or retired}]]$
 - b. * *alternative* question:
 $Op_i [\text{do you believe } [NP \text{ the claim that Bill } [\epsilon_i \text{ resigned or retired}]]]$

In (4), the disjunctive phrase *resigned or retired* is inside a complex NP. The alternative question reading is not available since the empty operator would have to move out of an island to generate this reading. But the *yes-no* question reading is available, since under this reading the empty operator is moving from the unpronounced *or not*, which is not inside an island.

2.2 On Disjunction in Negative Declaratives

Before extending Larson's analysis to negative questions, we need to understand his treatment of disjunction scope in negative declaratives. Larson claims that (5) only has the reading where negation has scope over the disjunction. This is the reading represented in (5a), according to which John drank neither coffee nor tea. The reading represented in (5b), according to which John drank either coffee or tea, is claimed to not exist.

- (5) John did not drink coffee or tea.
- a. John did not drink $Op_i [\epsilon_i \text{ coffee or tea}]$. He drank juice. (narrow scope *or*)
 - b. * Op_i John did not drink $[\epsilon_i \text{ coffee or tea}]$. But I don't know which. (wide scope *or*)

According to Larson, the scope of disjunction is determined by the movement of a scope indicating operator from the disjunction phrase to higher up in the clause. In *yes-no* questions, the scope indicating operator is overt or empty *whether*, and in declaratives it is *either* or a corresponding empty *either* operator. Adopting the semantics of disjunction in Rooth and Partee (1982), Larson argues that a disjunctive phrase introduces a free variable that must be bound by the scope indicating operator that originates from the disjunctive phrase. This is how the scope of disjunction is marked. Larson further assumes that negation always introduces existential closure, which unselectively binds any free variable under its scope. In (5b), the empty operator cannot bind the free variable introduced by the disjunctive phrase because it is already bound by the existential closure of the intervening negation. But in (5a), the empty operator binds the free variable of the disjunctive phrase since the negation does not intervene between the operator and the disjunctive phrase.

2.3 Extending Larson (1985) to Negative Questions

Let us now apply Larson's analysis to negative *yes-no* questions. We will see that he correctly predicts that *n't*-questions only have the *yes-no* question reading, but he wrongly predicts that the alternative question reading is not available for *not*-questions. I repeat the questions in (2) as (6) and (7) below for convenience.

In (6), the empty *whether* operator can move from the unpronounced *or not* phrase to [Spec, CP], deriving the *yes-no* question reading. This is represented in (6a). But the empty operator cannot move from the disjunctive phrase *coffee or tea* to [Spec, CP], as in (6b). This is because the intervening negation introduces existential closure which binds the free variable of the disjunctive phrase, thereby blocking the empty operator from marking the disjunctive scope. And thus, the alternative question reading is correctly ruled out.

- (6) Didn't John drink coffee or tea?
- a. *yes-no* question:
Op_i (ϵ_i or not) [didn't John drink [coffee or tea]]
 - b. * alternative question:
Op_i [didn't John drink [ϵ_i coffee or tea]]

In (7), the *yes-no* question reading is derived by moving the empty operator from the unpronounced *or not* to [Spec, CP], as represented in (7a). However, under Larson's analysis, the alternative question reading is incorrectly predicted to be ruled out. This is because the intervening negation between

the empty operator in [Spec, CP] and the disjunctive phrase would block the empty operator from marking the disjunctive scope, as represented in (7b).

- (7) Did John not drink coffee or tea?
- a. *yes-no* question:
Op_i (ϵ_i or not) [did John not drink [coffee or tea]]
 - b. alternative question:
Op_i [did John not drink [ϵ_i coffee or tea]]

3 Syntactic Approach 1: Modifying Larson (1985)

Contrary to Larson (1985), I point out that in negative declaratives with a disjunctive phrase the disjunction can have scope over negation, given the right context. For instance, assume that my mother always bakes too many different kinds of pies for Thanksgiving dinner, and so every year, there are too many left-over pies. But this year, she decided not to make one of the pies she doesn't like, namely pumpkin pies and apple pies. In this context, I can say:

- (8) For Thanksgiving dinner this year, my mother is not going to make a pumpkin pie or an apple pie. But I don't know which.

According to the native speakers that I have consulted, the first sentence in (8) can have the reading paraphrasable as *My mother is not going to make a pumpkin pie or she is not going to make an apple pie*. This is the wide scope reading of disjunction over negation.

Further, we have already seen that in matrix negative *yes-no* questions with a disjunctive phrase, *not*-questions allow the disjunction to have scope over negation, deriving the alternative question reading, although this was not possible for *n't*-questions. It turns out that in indirect negative *yes-no* questions with a disjunctive phrase, both *n't*- and *not*-questions allow the disjunction to have scope over negation. Assume a context in which it is well known that John does not eat a particular type of meat for some reason, but I don't know which type he doesn't eat. So, I ask John to find out the correct information. In this context, both indirect questions in (9) can have the alternative question reading, as can be seen by the fact that both sentences in (9) can be continued with the phrase *because I don't know which*.

- (9) a. I asked John whether he doesn't eat beef or chicken (because I don't know which).
b. I asked John whether he does not eat beef or chicken (because I don't know which).

One way of deriving the interpretive representation in which disjunction scopes over negation is by allowing the disjunctive phrase to undergo LF movement. For instance, in (8), we can assume that *a pumpkin pie or an apple pie* is a generalized quantifier that can undergo QR (quantifier raising) to IP at LF. If it undergoes QR, then it escapes negation, and the free variable of the disjunction phrase will not be existentially closed, leaving it free to be bound by the empty operator that is higher in the clause, as represented in (10a). This derives the reading in which disjunction scopes over negation. On the other hand, if the disjunction phrase does not undergo QR, then the free variable is bound by the empty operator that is lower in the clause, as represented in (10b), deriving the reading in which negation scopes over the disjunction.

- (10) ~a. [_{IP} Op_i [ϵ_i a pumpkin pie or an apple pie]_j [_{IP} My mother will not make t_j]]
 b. [_{IP} My mother will not make Op_i [ϵ_i a pumpkin pie or an apple pie]]

Now we can apply this analysis to negative questions. The explanation for the availability of the *yes-no* question reading in (6) and (7) is trivial. These questions have an unpronounced *or not* that contributes a free variable, and it gets bound by the empty *whether* operator. As for the (un)availability of the alternative question reading, in (6), *coffee or tea* can undergo QR to IP, but it cannot QR higher than negation *n't* since *didn't* is in C⁰. The variable introduced by disjunction would be bound by the existential closure introduced by negation and so the alternative question reading is ruled out. In (7), if *coffee or tea* undergoes QR to IP, then it is not under the scope of negation *not* anymore. And so, the free variable of disjunction can be bound by the empty *whether* operator, deriving the alternative question reading.

What if the disjunction phrase is not a generalized quantifier, as in (11)? In (11), the items in disjunction are verbs.

- (11) Did John not dance or sing at the wedding?

We can say that the disjunction *V dance or sing* moves to I⁰ at LF. Assuming that negation projects below INFL, the disjunction is above negation at LF. Thus, the empty *whether* will bind the free variable of the disjunctive phrase and so the alternative question reading is derived.

So far, we have seen examples in which QR and LF verb movement can be argued to be involved. Given that these two operations are independently motivated for English, the analysis that assumes LF movement of the disjunction phrase seems attractive (cf., Chomsky 1995, May 1985). But what if the

disjunctive phrase is adjectival, as in (12)? Assume a context in which it is well-known that John didn't date girls with a particular hair color last year.

- (12) Did John not date any blond or red haired girls last year?

The NP *any blond or red haired girls* has to stay lower than negation because the negative polarity item (NPI) *any* has to be licensed by negation.¹ But we have to get the disjunction out of the scope of negation to get the alternative question reading. But then, we would be forced to move just the adjective phrase *blond or red*. However, it is difficult to independently motivate LF adjective movement in English. Consequently, the analysis that assumes the movement of the disjunction phrase cannot be successful.

4 Syntactic Approach 2: Gapping

Schwarz (1999) argues that the syntax of *either...or* can be assimilated to the syntax of coordinate constructions that involve *gapping*. Gapping originally refers to the grammatical process which is responsible for the deletion of a verb in the second coordinate of a conjunctive coordination under identity with the first coordinate, as in (13) (Ross 1970). The deleted material in the second coordinate is called *gap*, and the materials in the second coordinate that have not been deleted are called *remnants*. I represent the gaps with parenthesis.

- (13) a. Tom has a pistol and Dick a sword.
 Tom has a pistol and Dick (has) a sword. (Schwarz 1999, 30a)
 b. Some ate beans and others rice.
 Some ate beans and others (ate) rice. (Schwarz 1999, 30b)

Schwarz points out that gaps may contain more than just a verb, although the finite verb of the second coordinate is always included in the gap, and argues that this fact is comparable with the idea that *either...or* constructions involve gapping.

¹ Although *yes-no* questions in general license NPIs such as *any* and *ever*, alternative questions do not, as pointed out by Ladusaw (1980) and Higginbotham (1993). For instance, the question in (1a) is ambiguous between a *yes-no* question and an alternative question, whereas the question in (1b) can only be interpreted as a *yes-no* question.

- (1) a. Did John play chess or checkers?
 b. Did anybody play chess or checkers?

NPIs in alternative questions are allowed only when there is an explicit licenser such as negation, as shown in (12). See Higginbotham (1993) and Han and Siegel (1997) for an account of NPI licensing in *yes-no* questions and alternative questions.

- (14) a. Bill must eat the peaches quickly and Harry slowly.
 Bill must eat the peaches quickly and Harry (must eat the peaches) slowly. (Schwarz 1999, 33a)
- b. * Bill must eat the peaches quickly and Harry might slowly.
 Bill must eat the peaches quickly and Harry might (eat the peaches) slowly. (Schwarz 1999, 30b)

According to Schwarz, in *either...or* constructions, *either* marks the left periphery of the first disjunct, and some materials in the second disjunct are deleted under identity with the first disjunct.

- (15) a. John either ate rice or beans.
 John either [_{VP} ate rice] or [_{VP} (ate) beans] (Schwarz 1999, 28a)
- b. Either John ate rice or beans.
 either [_{IP} John ate rice] or [_{IP} (John ate) beans] (Schwarz 1999, 28b)

One piece of supporting evidence for gapping analysis of *either...or* constructions comes from what Schwarz calls *dangling remnants*. Dangling remnants would occur in the second conjunct of a coordinate construction if you were to have elision in both the first and the second conjunct. Schwarz points out that dangling remnants are prohibited in coordinate constructions, and shows that they are prohibited in *either...or* constructions as well.

- (16) a. * Some talked about politics and others with me about music.
 some talked (with me) about politics and others (talked) with me about music (Schwarz 1999, 40b)
- b. * John dropped the coffee and Mary clumsily the tea.
 John (clumsily) dropped the coffee and Mary clumsily (dropped) the tea (Schwarz 1999, 41b)
- (17) a. ?? Either this pissed Bill or Sue off.
 either this pissed Bill (off) or (this pissed) Sue off (Schwarz 1999, 43a)
- b. ?? Either they locked you or me up.
 either they locked you (up) or (they locked) me up (Schwarz 1999, 43c)

Let us then apply Schwarz's gapping analysis of *either...or* constructions to *whether...or* constructions. *Whether* would mark the left periphery of the first disjunct and some materials from the second disjunct would be deleted under identity with the first disjunct. We will see that this analysis makes

correct predictions for *not* questions, but not for *n't* questions. As in Larson (1985), I am assuming that direct *yes-no* questions have the empty *whether* operator in [Spec, CP], and that these questions can have unpronounced *or not*. In (18), the empty *whether* has the option of being associated with *or* in *coffee or tea* or with *or* in the unpronounced *or not*. If it is associated with *or* in *coffee or tea*, the alternative question reading is derived, and if it is associated with *or* in *or not*, then the *yes-no* question reading is derived.

- (18) Did John not drink coffee or tea?
- a. (whether) [did John not drink coffee or tea] [(or not) (did John not drink coffee or tea)]
 $\approx$ (whether) [did John not drink coffee or tea] [(or did John drink coffee or tea)]
 - b. (whether) [did John not drink coffee] [or (did John not drink) tea]

In (19), the empty *whether* also has the option of associating with the *or* in *coffee or tea* and the *or* in the unpronounced *or not*. But then, both the alternative question reading and the *yes-no* question reading are wrongly predicted to be available for *n't* questions. But we have already seen that only the *yes-no* question reading is available for *n't*-questions.

- (19) Didn't John drink coffee or tea?
- a. (whether) [didn't John drink coffee or tea] [(or not) (didn't John drink coffee or tea)]
 $\approx$ (whether) [didn't John drink coffee or tea] [(or did John drink coffee or tea)]
 - b. (whether) [didn't John drink coffee] [or (didn't John drink) tea]

In fact, Schwarz points out that gapping analysis is not appropriate for *whether...or* constructions since they allow dangling remnants, unlike *either...or* constructions and other coordinate constructions with gapping.

- (20)
- a. Did this piss Bill or Sue off?
 - b. Did she turn the test or the homework in?
 - c. Did he gulp one or two down?

The questions in (20) can all have the alternative question reading. However, if we were to apply the gapping analysis to these questions, then we would end up with dangling remnants, which were prohibited from other gapping constructions.

Furthermore, *whether...or* constructions behave differently from other gapping constructions in that while remnants in gapping constructions cannot be in embedded finite clauses, they can be in *whether...or* constructions.

- (21) a. * The first letter says that you should pay tax and the second letter
 V.A.T.
 [the first letter says that you should pay tax] and [the second
 letter (says [that you should pay] V.A.T)] (Schwarz 1999, 61a)
- b. ?? Either Bill said that Mary was drinking or playing video games.
 Either [Bill said that Mary was drinking] [or (Bill said [that
 Mary was) playing video games]]
- (22) a. Did John say that Bill retired or resigned?
 b. Did John claim that Bill drank coffee or tea?

The questions in (22) all have the alternative question reading available. If this reading was derived via gapping in the second disjuncts in (22), then the remnants would be in embedded finite clauses. But this was impossible in other gapping constructions.

5 A Non-Syntactic Approach

We have so far considered and rejected two alternative syntactic approaches to account for the interpretive asymmetry between *n't*-questions and *not*-questions exemplified in (2). One approach was an extension of Larson (1985) to include LF movement of the disjunction phrase, and the other was an extension of Schwarz's (1999) gapping analysis on *either...or* constructions to *whether...or* constructions.

Here, I suggest that we go back to Larson's (1985) analysis, but this time abandon his assumption that negation always introduces unselective existential closure. In other words, as in Larson, let us assume that disjunction scope in *yes-no* questions is determined by the movement of the empty *whether*-operator from the disjunction phrase, but unlike Larson, let us allow this operator to move over negation. This is well-motivated given the fact that disjunction can take scope over negation even in negative declaratives in certain contexts, as was shown in (8).²

Allowing the empty *whether*-operator to move over negation allows disjunction to scope over negation in a *not*-question like (7). This correctly permits the alternative question reading that Larson's original account ruled out. But now disjunction can scope over negation in *n't*-questions as well, which

² Although negative declaratives with a disjunction phrase do allow a reading where the disjunction takes scope over negation, the fact is that the most easily accessible reading is the one where negation scopes over the disjunction. I leave open the question as to why this should be so.

we know lack the alternative question reading. An explanation of this lack, therefore, cannot come from the syntax alone.

I propose that the the syntax indeed allows both the alternative question and the *yes-no* question readings for *n't*-questions as well as *not*-questions. But the syntax interacts with the interpretive component of the grammar to rule out the alternative question reading for *n't*-questions. That is, the alternative question reading gets ruled out for *n't*-questions because the interpretation contributed by *n't*-questions and the interpretation contributed by alternative questions are incompatible with each other.

Direct negative *yes-no* questions formed with *n't* are associated with a special conventional implicature which cannot be cancelled.

- (23) a. Isn't John intelligent?
 b. Is John not intelligent?
 c. Is John intelligent?

Yes-no questions formed with *n't* implies that the speaker has a bias towards the answer: s/he expects the answer to be in the affirmative. The question in (23a) is used when the speaker expects the hearer to simply agree that John is intelligent by answering *yes*, or when s/he believes that John is intelligent but s/he is surprised that the hearer does not seem to share this belief. However, *yes-no* questions formed with *not* do not necessarily have this implicature. (23b) can be a polite way of asking whether John is stupid. Moreover, the affirmative *yes-no* question in (23c) does not imply that the speaker has a bias towards an answer either. It is a neutral way of asking whether John is intelligent or not.

As for the alternative questions, they do not imply that the speaker has a bias towards the answer. They presuppose that the answer to the question is either of the alternatives posed by the question, but they do not imply that one answer is more likely to be true than the other.

- (24) Did John drink coffee or tea?

For instance, (24) under the alternative question reading does not imply that the speaker expects that it is more likely that *John drank coffee* or that *John drank tea*.

Now to explain the problem at hand, the conventional implicature associated with *n't*-questions is not compatible with alternative questions. The implicature associated with an *n't*-question is that one particular answer is presupposed to be true. But alternative questions by definition cannot have any conventional signal as to which of the possible answers is presupposed to be true. This means that given an alternative question interpretation, it would

be impossible to calculate the implicature associated with the *n't*-question. I postulate that this conflict cancels the alternative question reading for *n't*-questions rather than canceling the implicature associated with it. In contrast, *not*-questions and affirmative *yes-no* questions are not associated with the implicature that the speaker has a bias towards an answer. And so, they can be interpreted as alternative questions.

Recall from section 3 that indirect *yes-no* questions allow both the *yes-no* question reading and the alternative question reading for *n't*-questions as well as *not*-questions (and also for affirmative indirect *yes-no* questions), as shown in (25) ((25a) and (25b) are repeated from (9)).

- (25) a. I asked John whether he doesn't eat beef or chicken.
 b. I asked John whether he does not eat beef or chicken.
 c. I asked John whether he eats beef or chicken.

This is predicted by the non-syntactic approach proposed here. Indirect *n't*-questions are not associated with the implicature that the questioner expects the answer to be in the affirmative, just as in indirect *not*-questions and indirect affirmative *yes-no* questions.

- (26) a. I asked Mary whether John isn't intelligent.
 b. I asked Mary whether John is not intelligent.
 c. I asked Mary whether John is intelligent.

Under the non-syntactic approach, the alternative question reading is expected to be available for the indirect *yes-no* questions in (25) because they are not associated with a conventional implicature that is incompatible with the alternative question reading.

6 Conclusion

In this paper, I have made a novel observation about negative *yes-no* questions in English: namely, the alternative question reading is available for *not*-questions but not for *n't*-questions. I have argued that the interpretive asymmetry attested between *n't*-questions and *not*-questions cannot be accounted for in syntax. Instead, I have proposed that the syntax makes available both the *yes-no* question and the alternative question readings for *n't*-questions as well as *not*-questions, but the alternative question reading is ruled out for *n't*-questions due to the incompatibility in the interpretation contributed by *n't*-questions and alternative questions. That is, *n't*-questions are associated with the conventional implicature that the speaker expects the answer to be in the

affirmative and this implicature is not compatible with alternative questions. Although the question remains as to why *n't*-questions are associated with this implicature, if the conclusions reached in this paper are correct, the interpretive asymmetry in *n't*-questions and *not*-questions is another case that has implications for the close interaction between structure and interpretation in the grammar.

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A Categorial Syntax for Verbs of Perception

Robin Clark and Gerhard Jäger

1 Introduction

"Categorial Grammar" is not a particular grammar formalism, let alone a theory of grammar, but rather a cover term for a family of quite diverse approaches to natural language syntax. This cover term is nonetheless useful, since all these theories share important characteristics. Besides the common foundation in the works of Ajdukiewicz (1935) and Bar-Hillel (1953) and the use of complex syntactic categories built up from atoms with slashes, they are based on two related premises that distinguish them from all other theories of grammar:

1. The locus of grammatical generalizations is the lexicon.
2. Constituent structure plays no role in grammatical theory.

This does not entail that Categorial Grammars deny the existence of constituent structure (in fact, Bar-Hillel's Basic Categorial Grammar and Lambek's (1961) non-associative grammar calculus assume a rigid binary branching structure). However, all Categorial Grammars assume that constituent structure cannot enter grammatical description.

The hypothesis that constituent structure is immaterial to grammatical descriptions contrasts sharply with the perspective found in the generative tradition. Generative grammar is largely grounded on relations like *c-command*, *m-command* and *government* which are based on tree geometry. Some theories have defined grammatical relations like *subject* and *object* entirely in terms of constituent structure; for example, the subject of a category *X* is that nominal which occurs the *Spec(X)*.

Since such a strategy is not viable in Categorial Grammar (CG henceforth), researchers working in this tradition usually do without notions like "subject" etc. The bundle of properties that are associated with subjects are considered to be logically independent. So it seems that CG misses an important generalizations.

The paper tries to counter this objection by demonstrating that the configurational notion of "subject" in fact leads to analyses that are descriptively inadequate. This point will be made by a case study of naked infinitive (henceforth: NI) perception reports as in:

- (1) Jackie saw Oswald shoot Kennedy.

Several tests indicate that the accusative NP *Oswald* is the subject of the embedded VP *shoot Kennedy*. Under a configurational notion of "subject" this implies that the string *Oswald shoot Kennedy* forms a sentential constituent. On the other hand, there is firm evidence both from syntax and semantics that this string should not be considered a constituent. We will attempt to show that (a) in a categorial setting, some of the subject properties of the accusative NP in NI perception reports can be derived without recourse to constituent structure, and (b) that this frees the way to a fairly simple semantics of perception verbs that solves most puzzles from the literature in a straightforward way.

2 Subject Properties and NI Perception Reports

Compare the following two sentences:

- (2) a. John saw that Bill left.
b. John saw Bill leave.

Examples (2a) and (2b) both involve John's perception of something, although their entailments are rather different. Example (2a), epistemic perception, entails that John has perceived that Bill left and has understood that Bill left. In other words, John has understood the content of his perceptions; the following should be anomalous:

- (3) John saw that Bill left but he didn't know it.

Notice that example (2a) does not entail that John actually saw the event of Bill's leaving. He could, in fact, have drawn the inference that Bill left through a fairly complex chain of deductions.

Example (2b) is quite different. In this case, John must actually have visually perceived the event of Bill's leaving although he may not have understood that that was what he saw. As Barwise (1981) observes, the following sentence:

- (4) Nixon saw Mrs. Wood erase the tape.

does not imply that Nixon understood what he was seeing. He may have thought that she was engaged in a peculiar calisthenic exercise, for example.

Barwise argues that the tensed complement to a perception verb, as in (2a) involves "epistemic perception," that is, perception with some cogitation, while the naked infinitive complement, as in (2b), involves non-epistemic perception, that is raw perception without any additional non-perceptual cogitation. Thus, I can see John embezzle money without seeing that John is embezzling money simply because I can perceive events in the world without understanding their import.

These intuitions have led to the standard analysis of the syntactic properties of verbs of perceptual report. Epistemic perception is a relation between an individual and a proposition. Assuming that the syntactic category CP corresponds to propositions, then, syntactically, this corresponds to a CP complement to the perception verb. What about non-epistemic perception? Barwise argued that the proper syntactic analysis was along the lines shown in (5):

- (5) [_{VP} see [_{XP} John [_{VP} run]]]

where *XP* is some category distinct from CP. The representation in (5) is meant as a cover for a set of analyses that take the immediately post-verbal NP as forming a constituent with the naked infinitive. A direct consequence of this analysis is that the denotation of *XP* must be distinct from CP since (2a) and (2b) are not synonymous. Since CPs denote propositions, *XP*, whatever its category, must denote something other than a proposition; Barwise argues that *XP* must denote a scene, a visually perceived situation. This, in turn, lends support to his thesis that situations are a basic semantic category.

Syntactic facts *prima facie* support this syntactic analysis. To start with, non-thematic elements can occur in the postverbal position (as pointed out by Gee 1977:468):

- (6) a. John saw it rain.
b. ?I've never seen there be so many complaints from students before.¹
c. John saw the shit hit the fan.

Example (6a) shows that weather *it* can occur in the postverbal position. In (6b), presentational *there* occurs in this position and in (6c) an idiom chunk can occur in this position with its idiomatic interpretation. Note that weather *it*, presentational *there* and idiom chunks have the property that they are, in some sense, non-referential.

Consider, first, examples (6a) and (6b). According to classical Government-Binding theory, the only way that the postverbal NP could be a direct

¹This is given as grammatical by Gee (1977).

object of the verb is if the verb assigns it a thematic role; this is the content of the *θ-Criterion*. By "direct object" we mean, of course, that the NP is a sister to the verb in the parse tree. But if the position were associated with a thematic role, then non-referential elements would be excluded from that position. The only syntactic position that is both non-thematic and associated with a grammatical function is the structural subject position and, therefore, non-referential elements are restricted to this position unless they are part of an idiom that includes the entire verb phrase as well. Turning to example (6c), we see that the postverbal NP receives its idiomatic interpretation. Therefore, it is non-referential and cannot be a sister to the main verb. This again shows that the postverbal NP in NI complement examples is a structural subject and not a direct object. The only way to satisfy this condition is if the postverbal NP forms a constituent with the naked infinitive.

Thus, NI constructions seem to class with so-called "Exceptional Case Marking" constructions, shown in (7), and small clause constructions², shown in (8), in allowing a non-thematic element to interceded between the verb and the embedded predicate.

- (7) a. John believes Bill to have stolen the car.
 b. John believes it to be raining.
 c. John believes it to be obvious that Bill stole the car.
 d. John believes there to have been a riot in the park.
 e. John believes the shit to have hit the fan.
- (8) a. John considers Bill a genius.
 b. John considers it obvious that Bill stole the car.

The crucial point here is that the presence of "a-thematic" material is diagnostic of the grammatical function *subject*; the grammaticality of the (b-e) examples in (7) show that the postverbal NP is a true subject of the following predicate and not the structural object of *believe*. We must, therefore, contrast the behavior of the postverbal NP in (7) with its behavior in an object control construction:

- (9) a. John persuaded Bill to steal the car.
 b. *John persuaded it to rain.
 c. *John persuaded it to be obvious that Bill stole the car.

²Because their predicates are not verbal, small clause constructions do not show the same range of non-thematic material in the following position. We take this as largely tangential to our main point.

- d. *John persuaded there to be a riot in the park.
- e. *John persuaded the shit to hit the fan.

The contrast between the ECM constructions in (7) and the control constructions in (9) present CG with an interesting problem. Generative grammar accounts for the contrast by associating subject properties with a particular piece of tree geometry, where, by subject property we mean things like:

- (10) a. The subject is allowed to be non-thematic;
- b. The subject is the "target" (or "landing site") of raising operations;
- c. The subject is a "licensed" controller;
- d. The subject is a "trigger" for certain agreement relations;
- e. The presence of a subject defines local domains for binding.
- f. Subjects are islands to extraction.

The list in (10) can, of course, be expanded and clarified. Our point is that in classical generative accounts all of the properties in (10) are unified under a particular geometric approach to grammatical relations; thus, establishing one of the properties in (10) is sufficient to establish constituent structure and endow to element in question with the full array of subject properties.

Grammatical subjects are traditionally treated as possible landing sites for raising processes like subject-to-subject raising (SSR) and passive. NI constructions admit *get* passives but *be* passives are more marked:

- (11) a. John saw Bill get examined by a doctor.
- b. *?John saw Bill be examined by a doctor.

Furthermore, the post-verbal position in NI constructions admits only a few cases of SSR:

- (12) a. John saw Bill appear to unlock the safe.
- b. ?John saw Bill seem to escape from the handcuffs.
- c. *John saw Bill be likely to drink too much.
- d. *John saw Bill tend to drive on the wrong side of the road.

The unacceptability of examples (12c) and (12d) are easily accounted for on the basis of semantic properties of the embedded predicate; it is difficult to imagine the exact visual manifestations of being likely to drink too much and tending to drive on the wrong side of the road, both properties being propensities that should be treated modally. Appearing and seeming, on the other hand,

can involve deliberate deceptions that can be visually realized—stage magicians make this their stock in trade. Because of this intentionality, *appear* and, to a lesser extent, *seem* may involve semantic relations between the “raised” subject and the predicate that are unavailable in the true raising constructions associated with *likely* and *tend*. Similarly, *get* passives may be preferred over *be* passives in NI constructions because of secondary semantic properties associated with the former but unavailable in the latter; compare, for example, the contrast between *get* and *be* in certain imperative constructions:

- (13) a. Don't get killed.
b. *Don't be killed.

The contrast in (13) is probably attributable to differences in the aspectual properties associated with *get* and *be*. These differences may also account for the contrast between (11a) and (11b). In particular, *be* passives tend to have a more stative flavor than *get* passives, a fact which may limit their distribution in NI constructions. As was the case for the distribution of pleonastics, then, raising and passive provide only equivocal support for the subject status of the post-verbal NP in NI constructions; while the post-verbal NP does show some subject properties, other factors associated with the semantics of perceptual reports intervene.

A further subject property involves the distribution of anaphors and here the facts are much more straightforward. Putting aside formal details, let us suppose, following classical Government-Binding Theory, that subjects create a minimal domain for binding; that is, the presence of a structural subject on a constituent guarantees that a syntactic anaphor like *himself* or *each other* must be bound within that constituent while pronominals like *her* or *them* must be unbound in the same domain. It follows that if the postverbal NP in NI constructions is a structural subject, then it should create a minimal domain for binding. The following data are consistent with this view of binding domains:

- (14) a. John saw Mary scratch herself.
b. *John saw Mary scratch himself.
c. John saw Mary scratch him.
d. *John saw Mary scratch her.

Examples (14a) and (14b) show that anaphors like *herself* must indeed find their antecedent within the domain defined by the postverbal NP; *Mary* in example (14a) is proximate to the anaphor *herself* and, so, is a legal antecedent for it; *John* in example (14b) is too distant to serve as a legal antecedent for

himself since the NP *Mary* inscribes an opaque domain for binding due to its status as a subject. Similarly, examples (14c) and (14d) show that *John* can be a possible antecedent for the pronoun *him* because *Mary* defines the minimal domain within which the pronoun must be free. Equally, the pronoun *her* in (14d) cannot be coreferential with *Mary* because the latter is within the pronoun's minimal domain; it cannot be coreferential with *John* because they disagree in gender.

Finally, we note that subjects tend to be islands to extraction:

- (15) a. **who_i* did friends of *t_i* visit Bill?
 b. **which saint_i* does Fred consider stories about *t_i* utter fabrications?

The ungrammaticality of the examples in (15) can be attributed to the fact that the *wh*-element is associated with a gap inside a subject, a tensed clause in (15a) and an small clause in (15b). The post-verbal NP in NI constructions is likewise an island for extraction:

- (16) **who_i* did John see a friend of *t_i* steal a car?

The analysis of the post-verbal NP in NI constructions as a true subject can immediately treat (16) as a violation of the islandhood of subjects.

As we have seen, the accusative NP in NI perception reports shows properties that are traditionally taken to be indicative of subjects. Under the configurational definition of "subject", it is thus inevitable to consider the string [*NP_{acc}VP_{inf}*] as a constituent.

In the next section we will collect a series of syntactic arguments that challenge this conclusion.

3 Other Syntactic Tests for Constituency

Observations concerning coordination and anaphora also point towards a one-constituent analysis. This can be seen from examples (17a) and (17b).

- (17) a. John saw Mary enter and Bill leave?
 b. John saw Mary enter, and Bill saw it too.

Akmajian (1977) points out that virtually all tests for constituency apart from coordination and pronominalization indicate that the complement of NI perception verbs do not form a constituent though. So they cannot appear in the postcopular position of pseudoclefts:

- (18) *What we saw was Raquel Welch take a bath.

Neither can they be inserted into clefted positions:

- (19) *It was Raquel Welch take a bath that we saw.

They cannot be right node raised:

- (20) *?We could hear, but we couldn't see, Raquel Welch take a bath.

Finally, they cannot undergo object deletion:

- (21) *Raquel Welch take a bath is a breathtaking sight to see.

Additional evidence against a one-constituent analysis comes from topicalization in German. The underlying sentence structure in German is verb final. Main clauses display V-2, i.e., one constituent is obligatorily fronted, and the finite verb is placed immediately after this constituent. Thus if a string is a constituent, we expect that it can be topicalized. Let us apply this test to NI perception reports. The underlying word order can be seen in an embedded clause like (22):

- (22) weil der Polizist jemanden fliehen gesehen hat.
 since the policeman[nom] somebody[acc] escape[inf] seen[part] has.
 'since the policeman saw somebody escape.'

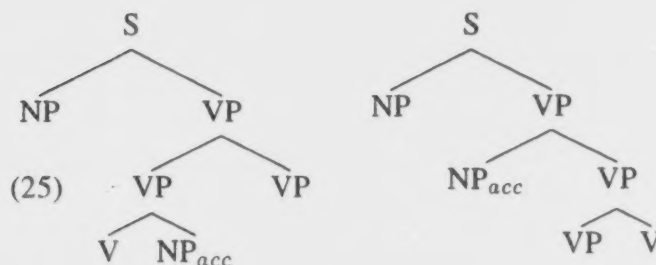
The topicalization test indicates that $NP_{acc} + VP$ do not form a constituent, while the sequence "embedded VP+matrix Verb" do:

- (23) a. ??? Jemanden fliehen hat der Polizist gesehen.
 Somebody escape has the policeman seen.
 b. Fliehen gesehen hat der Polizist jemanden.
 Escape seen has the policeman somebody.

So the appropriate bracketing for (22) should be (24a) rather than (24b):

- (24) a. weil der Polizist [jemanden [fliehen gesehen hat]]
 b. weil der Polizist [jemanden fliehen] gesehen hat.

All these observations indicate that the appropriate syntactic structure for NI perception reports should be like the trees in (25) for English and German respectively rather than the structure in (5), neither of which involves an embedded small clause.



4 Vlach's Puzzle

All detailed studies of the semantics of perception verbs that we are aware of start with a one-constituent analysis (see for instance Barwise 1981, Higginbotham 1983, Vlach 1983, van der Does 1991). And even though the ontological background differs considerably, they agree on the following:

1. Perception is a relation between an agent and an abstract object (scene/situation, event, partial model etc.).
2. The $[NP_{acc}VP]$ constituent in NI perception reports denotes a set of situations (events ...).
3. *John sees NP VP* can be paraphrased as *John sees a situation (event ...) s*, and $s \in ||[NP VP]||$.

Let us suppose, as seems reasonable, that active and passive sentences are supported by the same set of scenes and, so, denote the same proposition.³ In particular, (26a) and (26b) are true paraphrases, differing only in their pragmatic contributions and that (26c) differs from the other two only in the contribution of *get* to the interpretation of the sentence:

- (26) a. Oswald assassinated Kennedy.
 b. Kennedy was assassinated by Oswald.
 c. Kennedy got assassinated by Oswald.

Furthermore, let us follow the standard assumption that the semantic contribution of a passive sentence in an embedded context is exactly comparable, up to pragmatics, to the semantic contribution of an active sentence in the same context; thus, (27a) is a paraphrase of (27b):

- (27) a. John saw that Oswald assassinated Kennedy.

³Vlach likely wouldn't agree with this. His view is discussed below.

- b. John saw that Kennedy was assassinated by Oswald.

Notice, in particular, that no privileged relationship holds between John and either Oswald or Kennedy in either (27a) and (27b).

Compare this situation in (27) with the pair of sentences in (28), first observed by Vlach (1983):

- (28) a. John saw Oswald shoot Kennedy.
b. John saw Kennedy get shot by Oswald.

The behavior of the sentences in (28) is peculiar given the small clause analysis of NI complements, since (28a) and (28b) are not paraphrases of each other and differ by more than the contribution of *get* to (28b). In particular, for (28a) to be true it must be the case the John saw Oswald exactly when the latter shot Kennedy; John need not have seen Kennedy at all. For (28b) to be true, on the other hand, John must have seen Kennedy at the moment that he got shot by Oswald; he need not have seen Oswald at all. Thus, while (28a) is not true of anyone, many people have shared John's visual experience in (28b).

In brief, it would seem that the subject of the perception verb and the postverbal NP stand in some special relationship in non-epistemic perceptual reports, a relationship that is wholly absent in epistemic perceptual reports. To be more precise, we claim that the inference pattern in (29a) is valid, but the one in (29b) isn't.

- (29) a. $x \text{ saw } y \text{ VP} \models x \text{ saw } y$
b. $x \text{ saw } y [{}_{VP} V z] \models x \text{ saw } z$

The invalidity of (29b) is demonstrated by (28). To substantiate the claim that (29a) is valid, let us consider three putative counterexamples. Suppose, first, that John is standing behind an opaque plastic screen, using magnets to move metal puppets on the other side of the screen. Suppose Mary observes the movement of the puppets, without seeing John. Can Mary use (30) to report her perception?

- (30) I saw John move the puppets.

Gee (1977) claims that she can. The judgments of those we have asked is that although (30) is marginal in this context, it can be so used just in case Mary is absolutely certain that no one else could be responsible for the movement of the puppets. In this case, seeing puppet movement is tantamount to direct perception of John.

Similarly, consider the case where Mary is separated from a forest by a large hill, so that she cannot see the forest (this example is also due to Gee 1977). Observing a huge billow of smoke rising over the hill, can Mary later use (31) to report her experience?

(31) I saw the forest burn.

Again, the consensus of those we have asked is that (31) is odd in the above context. We can sharpen the intuition by considering the following sentence:

(32) I saw the forest burn even though I didn't see the forest.

According to our intuitions, this sentence is contradictory, no matter what background knowledge we assume.

The same argumentation applies *ceteris paribus* to an argument from van der Does (1991), who in turn attributes it to Robin Cooper. He raises the question whether an entailment relation holds between (33a) and (33b):

- (33) a. Daniel saw Lucia phone Henry.
b. Daniel saw Lucia.

Van der Does (op. cit., p 245) discusses the following scenario: "Imagine Lucia, Henry and Daniel each sitting in separate rooms. There are phones which enable Lucia and Henry to speak to each other, but only when Lucia phones Henry an oscilloscope in Daniel's room will show a patterns characteristic for Lucia's voice. Now suppose Daniel saw the patterns, can one report the fact by saying [(33a)]?" Van der Does claims that at least some subjects answered affirmatively, since "perceiving the pattern on the oscilloscope is perceiving a representation of Lucia, much as perceiving a video-recording of her would have been. And clearly in the latter sense [(33a)] might be used." We agree that (33a) might be true in such a situation, but so would (33b), and for the very same reason. In other words there might be some vagueness as to how direct perception should be, but the inference pattern is not affected by that.

To sum up the discussion so far, we observe a special semantic relationship between the matrix subject and the accusative NP in NI perception reports. In other words, $NP_{acc}VP$ don't form a semantic unit. This indicates that they don't form a syntactic unit either.

It should be mentioned that Vlach (1983), who was presumably the first to notice this special relationship, nevertheless uses a one-constituent analysis.

According to him, the difference in meaning between (28a) and (28b) is due to the fact that the denotation of *Kennedy shot by Oswald* consists of events that include Kennedy's location, while *Oswald shoot Kennedy* denotes a set of events that are locally connected to Oswald. Vlach doesn't give an explanation for this asymmetry, but apparently he assumes the event descriptions that include a subject denote events that are located at or around the location of the referent of the subject.

To test this assumption, consider (34).

- (34) Jackie saw Oswald's assassination of Kennedy.

Despite the fact that the subject of the event description is *Oswald* and Jackie didn't see Oswald, the sentence is true. So the location of an event that is described by an event noun is not determined by the location of the referent of the subject. Events that are described by tensed sentences do not confirm a special status of the subject either.

- (35) a. Oswald shot Kennedy.
 b. ?That happened in the Texas Book Depository.
 c. ?That happened in the Presidential Limousine.
 d. That happened in Dallas.

It appears that an event that is described by a tensed clause has to include all participants, not just the referent of the subject. So we may conclude that our argumentation above is supported. The accusative NP and the embedded VP shouldn't be considered to be a semantic unit.

What about the arguments in favor of a one-constituent analysis? There were two that didn't rely on grammatical functions, coordination and anaphora. In the next section, we will demonstrate that the former argument is not conclusive; non-constituents may be conjoined. Anaphora isn't a conclusive argument either. It is generally held nowadays that anaphora resolution operates on semantic entities rather than on syntactic constituents. We will argue below the meaning of (17b) does involve the event of Mary's entering, even though it does not correspond to any constituent. So we expect anaphoric reference to it to be possible.

5 The Semantics of Verbs of Perception

As our starting point we take the semantics of verbs of perception as proposed by Higginbotham (1983). This decision is of little significance, other proposals like Barwise's or van der Does' could be modified in a similar fashion.

Higginbotham assumes that verbs that can occur in the complement of NI perception reports have an event argument, and that the logical form of a sentence like (36a) is (36b).

- (36) a. John saw Mary leave.
b. $\exists e(\text{LEAVE}(M, e) \wedge \text{John sees } e)$

The variable e ranges over events here. The verb *see* that occurs with NI complements is thus semantically reduced to simple transitive *see*. As argued above, this semantics cannot be correct since then *seeing Oswald shoot Kennedy* would come down to seeing the whole event of Oswald's assassination of Kennedy, which in turn entails seeing Kennedy. The truth conditions of

- (37) Jackie saw Oswald shoot Kennedy.

are much weaker. To establish its truth, it is sufficient that Jackie saw that part of the complex assassination event the directly involved Oswald, i.e. his aiming and pulling the trigger. To accommodate this intuition, let us assume that for each participant x of an event e , there is a unique subevent e_x of e that has x as its only participant. We won't spell out this operation formally here, but the intuition should be clear enough. So the logical form of (37) should be

- (38) $\exists e(\text{SHOOT}(\text{LHO}, \text{JFK}, e) \wedge \text{Jackie sees } e_{\text{LHO}})$

It goes without saying that such a logical form can only be derived compositionally if the accusative NP *Oswald* is an argument of the matrix verb. This in mind, we can give the following lexical semantics of *see*:

- (39) $\lambda Pxy. \exists e(Pxe \wedge \text{SEE}(y, e_x))$

This is compatible with the following syntactic category of *see*, the Categorical counterpart to the second structure in (25).

- (40) $(N \setminus S)/VPI/N$

We leave irrelevant morphosyntactic details open. In particular, we do not spell out the internal structure of NI VPs but abbreviate its category with *VPI*.

In the sequel we will show that this semantics of verbs of perception, paired with a categorial syntax, meets the main criteria that are discussed in the literature.

Verdicality This is Barwise's name of the inference scheme

(41) John saw Mary leave $\models$ Mary left.

In an event based semantics, the logical form of *Mary left* is $\exists e : \text{LEAVE}(M, e)$. As under Higginbotham's original account, this follows from the premise by simple first order reasoning.

Extensionality All elements of an NI perceptual report are transparent, i.e., they can be replaced by extensionally equivalent expressions *salva veritate*. Since no intensional operators are involved in our semantics of *see*, this is predicted.

Absence of scope ambiguities Generally, all scope inducing items that might occur in one of the complements of *see* have matrix scope. Under our approach, this has nothing to do with the semantics of *see* but follows from its syntax. To start with, quantifiers in the accusative position always have matrix scope, for instance:

(42) John saw Q leave $\equiv Qx$ are such that John saw x leave.

Since the quantifier occupies an argument position of the matrix verb, it must at least take scope over the matrix VP, no matter what particular approach to quantifier scope we adopt.

Coordination behaves similarly, i.e., the following two equivalences hold.

- (43) a. John saw Mary swim and Bill walk $\equiv$ John saw Mary swim and John saw Bill walk.
 b. John saw Mary swim or Bill walk $\equiv$ John saw Mary swim or John saw Bill walk.

In any version of CG, conjunctions are considered polymorphic items. Their category is $X \backslash X / X$, where X ranges over Boolean categories.⁴ Roughly, a category is Boolean iff the corresponding semantic type ends up in t . So $S, N \backslash S, CN$ etc. are Boolean categories. The meaning of the coordination *and* is $\lambda QP\tilde{x}. P\tilde{x} \wedge Q\tilde{x}$. So in the first sentence in (43a), the substrings *Mary swim* and *Bill walk* have to be assigned a Boolean category each to make them conjoinable.

⁴Steedman's (1996) syncategorematic treatment of conjunctions amounts to the same thing.

Under any version of CG, the accusative NP and the NI phrase cannot be combined directly to yield a Boolean category. Thus as in the case of quantifier scope, the absence of a narrow scope reading is expected. We have to answer the question how the wide scope reading is to be derived though.

Up to the present point, we remained neutral as to which version of CG is to be used. To handle this puzzle, we have to be more specific. Since *Mary* and *swim* do not form a functor-argument structure here, we need a certain degree of associativity to deal with this instance of non-constituent coordination. So the example can be handled in any version of Combinatory Categorical Grammar (CCG, cf. Ades and Steedman 1982) that contains the operation of function composition, and in any descendant of Lambek's (1958) associative CG.

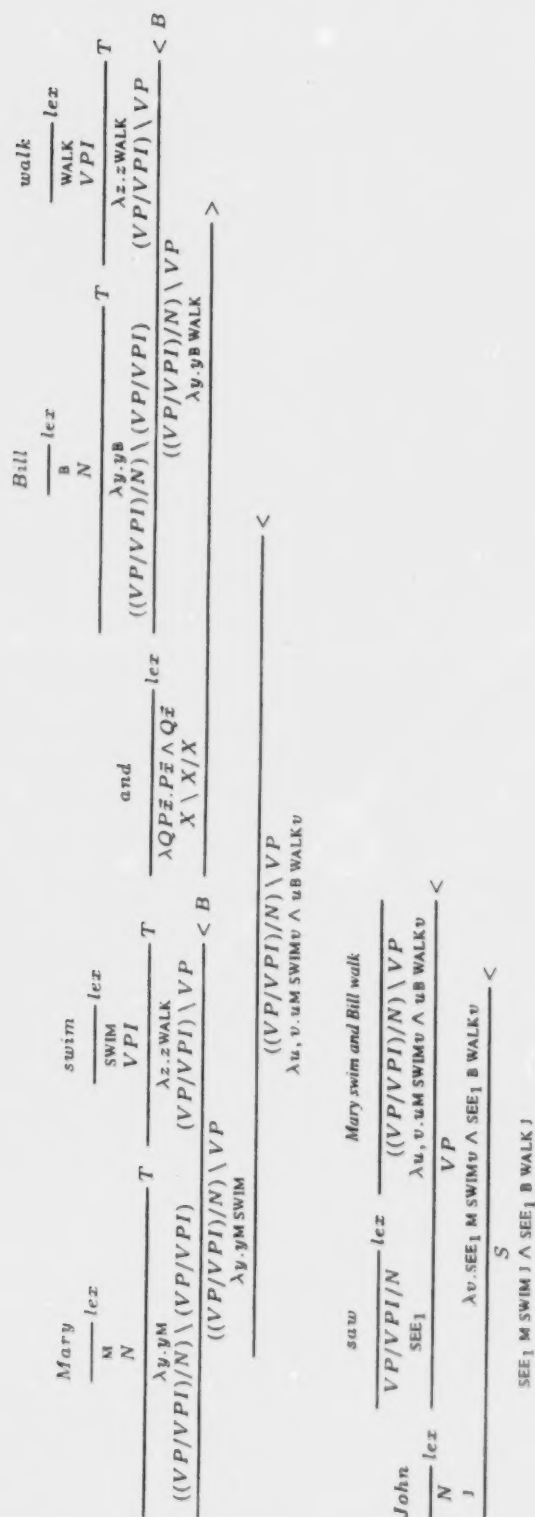
As shown in Fig. 5,⁵ the reading in question can be derived in CCG using only type lifting and backward function composition. We abbreviate $N \setminus S$ as VP for convenience. The predicate SEE_1 is shorthand for the meaning of *see* (cf. (39)). Since both combinators are theorems of the Lambek calculus, this is simultaneously a Lambek derivation.

Failure of logical equivalence Although the complements of perception verbs can be combined by the classical propositional connectives, complements that are equivalent in classical logic cannot always be exchanged *salva veritate*. For instance, (44b) doesn't have a reading that is equivalent to (44a).

- (44) a. Hegel saw Schelling sneeze.
 b. Hegel saw ((Schelling sneeze and Hölderlin eat) or (Schelling sneeze and Hölderlin not eat)).

To handle this problem, it has to be remarked that even though the use of propositional connective in the "complement" of perception verbs looks suggestive, we assume a different treatment of conjunction and disjunction on the one hand, and of negation on the other hand. The former connectives always receive a wide scope interpretation, while negation is predicate negation. Therefore we do not expect patterns that look like classical validities to be sustained. Under this treatment (44b) is synonymous with (45).

⁵The Combinatory branch of CG uses a format for complex categories and for derivation trees that differs somewhat from the Lambek tradition. We chose a compromise here in using the backslash in Lambek's sense (" $A \setminus B$ " takes an argument of type A and yields a value of type B) while choosing a CCG-style derivation tree.

Figure 1: Derivation of *John saw Mary swim and Bill walk*

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- (45) (Hegel saw Schelling sneeze and Hegel saw Hölderlin eat) or (Hegel saw Schelling sneeze and Hegel saw Hölderlin not eat).

By simple propositional reasoning we can infer *Hegel saw Schelling sneeze* from this. But furthermore we infer that there is an event *e* that involves Hölderlin and that is seen by Hegel. This does not follow from (44a), so (44a) and (44b) cannot be equivalent.

The puzzle of Russell's schoolchildren Barwise gives a further desideratum for an adequate semantics of perception reports which is illustrated by the following inference scheme.

- (46) a. Russell sees each boy touch at least one girl.
 b. Russell didn't see any girl being touched by more than one boy.
 c. $\models$ There are at least as many girls as boys.

As Vlach correctly observes, this inference scheme is not valid. Imagine a gameshow where 10 boys have to find a partner among 5 girls. The participants cannot see each other, but everybody sits in a booth with several phones each of which connects to exactly one participant of the opposite sex (so the boys have 5 phones and the girls 10 phones each). Each boy calls one girl, and it happens that each girl receives exactly two phone calls. So each girl picks up two receivers simultaneously and holds them to her ears (one receiver per ear). The TV audience can see all 15 participants, but they can only see the left side of the girls. Russell was watching this silly show on TV. In this situation (a) and (b) are true, but (c) isn't:

- (47) a. Russell saw each boy calling at least one girl.
 b. Russell didn't see any girl being called by more than one boy.
 c. There are at least as many girls as boys.

This is problematic for the theories of Barwise, Higginbotham, and van der Does, since they uniformly predict that if Russell sees *a* calling *b*, he also sees *b* getting a call by *a*. So if Russell would see two boys calling the same girl, he would see this girl getting a call from two boys. This makes the argument valid. Since we don't claim that Russell sees a girl called if he sees a boy call her, no such prediction is made.

To sum up this section, we tried to demonstrate that a fairly innocent modification of Higginbotham's proposal is sufficient to accommodate Vlach's puzzle while preserving its general advantages. Likely a similar adjustment

could be made with other theories of the semantics of perceptual reports. If we insist on compositional interpretation, this adjustment excludes a one-constituent analysis of the syntax of perceptual reports though. This in turn forces us to adopt a syntactic theory that is able to handle non-constituent coordination, as most versions of CG do.

6 Conclusion

In this paper, we have presented some arguments for a reanalysis of NI complements to verbs of perceptual report. We have argued that the semantic analysis that takes the NI complement as a constituent denoting a scene or situation fails to provide a satisfying account of certain entailments; these semantic properties follow directly on our account, which does not treat the NI complements as a single semantic unit.

Furthermore, our account handles many of the syntactic properties associated with NI constructions; indeed, it seems to fare at least as well as the standard small clause account. We are, however, left with a residual problem: How can we account for the subjectlike properties of the post-verbal NP? On the standard account, the subject properties of this NP follow because these properties are correlated with tree geometry. We believe, however, that this approach to grammatical relations requires an undesirable loosening of the relationship between the syntax and the semantics.

So while subject properties should not be considered as evidence for a particular constituent structure, they require an explanation nevertheless. As far as the Binding facts are concerned, this might be fairly straightforward if we assume that Binding means linking of the anaphor to an superordinate argument place of the local verb (see for instance the proposals of Szabolcsi 1988 or Hepple 1990). Under this perspective, the domain of Binding is the local VP rather than the local clause. The other subject properties discussed above have to be left as an open problem, however.

One virtue of CGs is that they maintain a homomorphic relationship between syntax and semantic structures. While CGs have a pleasingly axiomatic structure that clarifies the relationship between natural language syntax and logic, they provide no obvious account of grammatical relations. We believe, that one task for the grammarian is to elucidate the role that grammatical relations play both in syntax and in semantics. We have not, however, given such a theory in this draft, contenting ourselves with posing the problem as clearly as we could.

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Defective Complements in Tree Adjoining Grammar*

Seth Kulick, Robert Frank and K. Vijayshanker

1 Introduction

Syntactic theory has long made use of the idea that clausal complements can be different sizes. For example, while the finite complement to *believes* in (1a) projects up to CP, the nonfinite complement in (1b) projects only to IP. The most obvious reason for this approach is, of course, that the finite complement can have a complementizer, while the nonfinite one cannot. This is, in turn, related to accounts of how Case can be assigned to the complement subject when the complement is IP but not CP.¹ Another example of how smaller complements are used in syntactic theory is of course the case of subject-to-subject raising, as in (2a). Such raising is only possible when the complement is an IP, but not a CP (2b). Restrictions on movement are therefore correlated with the size of the complement.

- (1) a. John believes [_{CP} that [_{IP} Bill is a freak]]
- b. John believes [_{IP} Bill to be a freak]
- (2) a. Bill_i seems [_{IP} t_i to be a freak.]
- b. * Bill_i seems [_{CP} that t_i is a freak.]

This use of differing complement sizes has been extended to handle further types of inter-clausal movement, by increasing the options for the size of the complement. One particular case in which this approach has been taken is that of 'clitic climbing' in Romance, in which a clitic can sometimes appear in a higher clause than the clause to which it is semantically associated. Going back at least to Strozer (1977), various linguists have suggested that clitic climbing takes place when the complement is 'defective', even more so (that is, smaller) than for the complements of raising or ECM verbs, although the exact size of the complement has changed depending on the analysis and the options available within syntactic theory.

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¹There are different stories about how such exceptional Case marking takes place—either by governing across IP, or movement of the complement subject to [Spec, AgroP] in the higher clause, etc. These details do not matter here, since the main point is the utility of using complements of different sizes.

The purpose of this paper is two-fold. First, we discuss an analysis of clitic-climbing within the framework of Tree Adjoining Grammar (TAG). A 'defective complement' analysis was used in Bleam (1994) to account for clitic climbing in TAG. While the analysis is in several respects very successful, we point out some important cases that it is unable to handle. Indeed, following Bleam (1994)'s basic assumptions, it is difficult to give any such analysis for these cases in Tree Adjoining Grammar. Since we accept those basic assumptions, we therefore utilize a reconceptualization of Tree Adjoining Grammar proposed by Frank and Vijay-Shanker (1998), Frank et al. (1999).

While this approach allows the problems faced by Bleam (1994)'s analysis to be handled, it in turn faces certain challenges of prohibiting locality violations by clitic movement. Investigating this problem leads to the second goal of this paper, which is to show how the same derivational machinery used for subject-to-subject raising and *wh*-movement is also used for clitic climbing, resulting in a unified analysis of inter-clausal movement in this revised TAG framework, while still accounting for their different properties.

In Section 2 we present the data concerning clitic-climbing in Romance, and the TAG framework is introduced in Section 3. Section 4 discusses Bleam (1994)'s analysis and problematic cases for the analysis. Section 5 discusses the recharacterization of the TAG framework, and Section 6 shows how it can be used to solve the problems discussed in Section 4. Section 7 discusses the resulting analysis in more detail, showing how locality can be retained and how the solution fits into an overall account of inter-clausal movement in TAG, and Section 8 presents a short conclusion.

2 Data : Clitic Climbing in Spanish

We are concerned in this paper with Romance object-clitics, unstressed pronominal elements associated with the objects of a verb. The object as a full NP follows the verb, as in (3). In Spanish and Italian, the clitic precedes a finite verb (4), and follows a nonfinite verb (roughly) (5). We focus here on Spanish, although the same issues hold for Italian.²

- (3) Mari no vió la película
 Mari neg saw the movie
 'Mari did not see the movie'

²In both Spanish and Italian, the object clitics (roughly) appear following a nonfinite verb, and preceding a finite verb. We abstract away from this issue here.

- (4) Mari no *la* vió
 Mari neg it saw
 'Mari did not see it'
- (5) Mari quiere *verla*
 Mari wants to see it

Object clitic placement is usually a clause bound operation, in which the clitic appears on the verb with which it is associated (or on an auxiliary verb in the same clause). As shown in (6), the clitic does not in this case appear on the higher verb, but must appear on the verb it is semantically associated with, in this case *comer*.

- (6) a. Luis insistió en *comerlas*
 Luis insisted on eating them
 b. *Luis *las* insistió en comer

This is the 'typical' case. However, with a limited number of verbs, such as *quiere*, in addition to the clitic staying with the lower verb, as in (7a), it can also optionally appear on that higher verb, as in (7b). This is commonly referred to as 'clitic climbing', since the clitic appears to climb to a higher clause. I will follow Aissen and Perlmutter (1983) in referring to the verbs that allow such movement of the lower clitic to them, such as *quiere*, as the 'trigger' verbs.³

- (7) a. Luis quiere *comerlas*
 b. Luis *las* quiere comer
 'Luis wants to eat them'

The puzzle of sentences such as (7b) is, of course, is that the normal locality constraint on clitic placement, as in (6), seems to be violated. Furthermore, the clitic can move past a series of verbs, as long as those verbs are all trigger verbs, as in (8):

- (8) Juan *la* quiere poder comprar
 Juan it wants to be able to buy
 'Juan wants to be able to buy it'

³Clitic climbing is just one type of unexpectedly long movement allowed by trigger verbs. These different movements are commonly grouped together under the term 'restructuring'. Some of the other aspects, such as the 'long middle-*si*' raise some different issues for TAG, and also interact with clitic-climbing in interesting ways. However, space prohibits discussion here of these other aspects of restructuring.

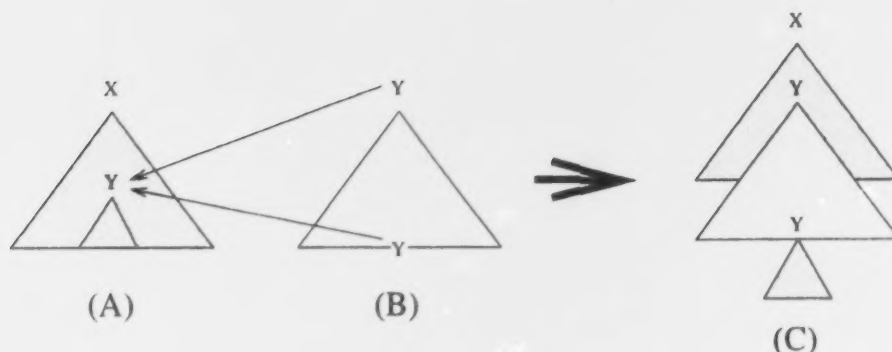


Figure 1: Adjoining in TAG

3 Tree Adjoining Grammar

The fundamental idea of TAG (Frank (1992), Kroch and Joshi (1985)) as a grammatical formalism is that the specification of grammatical constraints can be separated from the recursive processes in the grammar. This is accomplished by localizing the grammatical constraints within small pieces of phrase structure, called *elementary trees*, which are combined using the *adjoining* operation.

Adjoining inserts one elementary tree inside the body of another, as shown in Figure 1.

Trees which can be adjoined into another tree are *auxiliary trees*, and have a *foot* node along the frontier which is of the same category as the root node. Adjoining is what allows recursive structures to be separated from the specification of the grammar; recursive structures are treated as auxiliary trees, which adjoin in to produce non-local dependencies.⁴

The working hypothesis for all linguistic work in TAG is that the substantive theory of syntax must be stated over the bounded local domains of the elementary trees. It is also taken as a basic assumption that all semantic arguments associated with a verb are located in the same elementary tree as that verb. We follow here the characterization of elementary trees proposed by Frank (1992), in which an elementary tree consists of the extended projection,

⁴TAG also uses tree substitution, which by itself would only give the context-free power. The use of adjoining pushes TAG into the class of 'mildly context-sensitive' grammar formalisms (Joshi et al. 1990). Substitution is commonly used to insert arguments into a tree, a detail we have abstracted away from here. Substitution also plays a role in the definition of 'multi-component' TAG, as seen later in this section.

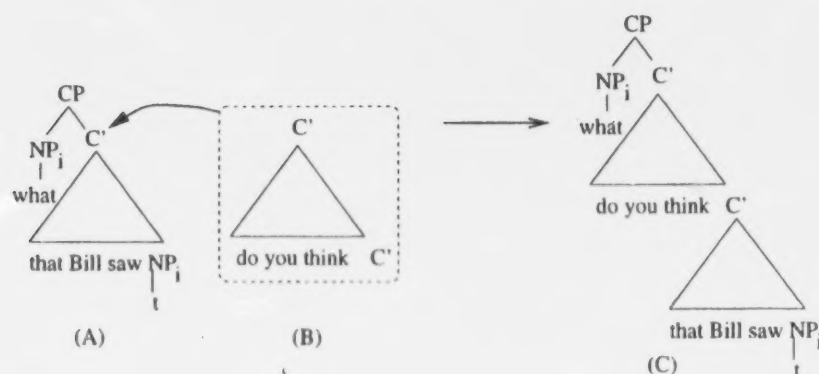


Figure 2: Wh-Movement in TAG

in the sense of Grimshaw (1990), of a lexical predicate:

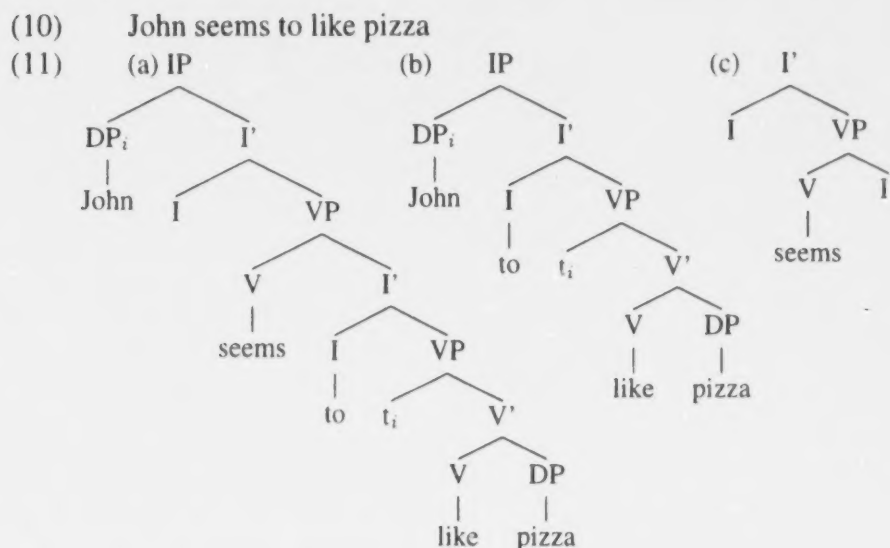
- (9) **Condition on Elementary Tree Minimality (CETM):** Every elementary tree consists of the extended projection of a single lexical head.

One example of the use of adjoining for recursive processes is given by the TAG analysis in Frank (1992), Kroch and Joshi (1985) of wh-movement, as in *What do you think that Bill saw?* The moved wh-movement and its trace are localized in single elementary tree for *What_i that Bill saw t_i*, as shown in (A) of Figure 2.

This is an example of how in TAG all movement transformations are localized to take place in a single tree. The auxiliary tree for *do you think*, (B) in Figure 2, is a C' auxiliary tree that adjoins in at the C' node of (A). This produces the desired result in (C), which shows how adjoining accomplishes the same result as inter-clausal movement, in this case cyclic A'-movement.⁵

Crucially, there is no 'movement' from one clause to another. All movement is internal to an elementary tree, and the appearance of inter-clausal movement results by segments of a tree getting stretched away from the rest of the tree, as illustrated by the *what* of (A) in Figure 2 being stretched away from the rest of (A) by the adjoining of (B).

⁵Note that complement of *think* takes a C' complement, which allows the tree to be used as a C' auxiliary tree. We are adopting here Frank (1992)'s proposal that the bridge verbs (the ones that allow movement from the complement of a lower clause) are the ones that take a C' complement, as opposed to non-bridge verbs such as *regret*, which take a CP complement and so cannot be used for inter-clausal wh-movement by



The same basic approach applies for subject-to-subject raising as in (10). The auxiliary tree in (11c) is adjoined into (11b) at the I' node, thereby 'stretching' *John* away from *to like pizza*, to produce (11a).

The operations of substitution and adjoining allow two elementary trees to interact with each other. A natural way to 'loosen' the definition of TAG is to allow the TAG operations to manipulate multiple trees at a time. These extensions are referred to as 'multi-component' extensions of TAG, since the basic components of the grammar are no longer trees, but tree sets with several components. One such extension, 'tree-local multi-component TAG' (TL-MCTAG), has been the most used for various problems that arise with basic TAG. TL-MCTAG requires that all of the members of a tree set be adjoined or substituted into a single elementary tree, as broadly illustrated in Figure 3. (A) and (B) in the figure show that two members can either both adjoin into another tree, or one component can adjoin while the other substitutes.⁶ What is not allowed by the definition of TL-MCTAG, though, is the scheme in (C), in which a tree adjoins into one component of the tree set, while the other component of the tree set adjoins into that tree. The consequences of this definition of TL-MCTAG for clitic climbing are discussed in the next section.

adjoining in the same way that *thinks* can.

⁶It is also possible for both to substitute.

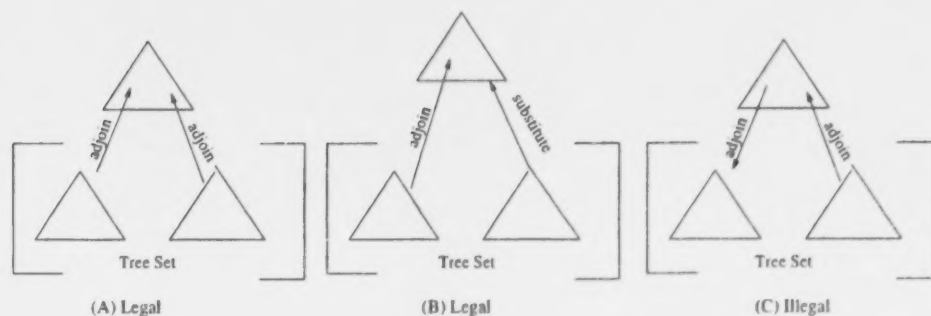


Figure 3: Tree-Local Multi-Component TAG

4 TAG and Clitic Climbing: The Problem and Previous Approaches

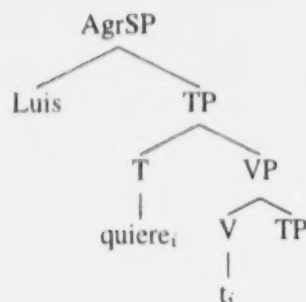
Consider again the the case of a clitic that does not 'climb', as in (7a), repeated here as (12a). Since the elementary tree for *comer* contains all the arguments of *comer*, it would naturally contain the clitic *las* as well. While there would be some issues over exactly the right way to represent the clitic in the phrase structure, that would be the case for any formalism, and there is no particular problem caused for TAG. Whatever the desired representation of the clitic is, it can be used in the elementary tree for the *comer* clause with the clitic.

- (12) a. Luis quiere comerlas
 b. Luis *las* quiere comer
 Luis wants to eat them

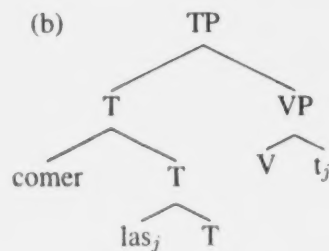
However, in a clitic climbing case such as (7b), repeated here as (12b), the clitic appears in the higher clause. Since, by the CETM, the clitic must be part of the *comer* elementary tree, it must therefore appear in the higher clause as a result of adjoining. As discussed in the previous section, the adjoining operation for TAG is able to 'stretch' away components of an elementary tree. For the case of *wh*-movement, e.g., *who does John think that Bill saw, does John think* adjoins in, pushing *who* away from *that Bill saw*. For subject-to-subject raising, as in *John seems to like pizza*, *seems* adjoins in to push *John* away. In both cases, the component that gets pushed away from the rest of its tree is on the periphery of the final sentence (*who* or *John*).

However, in (12b), the element being 'stretched away', the clitic *las*, is not on the periphery of the clause. The clitic appears somewhere 'in the middle' of the higher clause. This is therefore a problem for TAG.

(13) (a)



(b)



4.1 TAG and Clitic Climbing: Previous Approach

An analysis of clitic climbing in TAG was proposed by Bleam (1994).⁷ Bleam (1994) crucially adopts the idea that the trigger verbs are those which can optionally take a 'defective' complement, namely VP instead of a full IP (or AgrSP, in the split-Infl structure assumed). The clitic is taken to attach to the T node, and so when the defective complement VP is selected, the clitic has no place to attach in the complement clause, and so must climb up. When the trigger verb selects a 'full' complement that includes a TP projection, the clitic attaches to the T node and so does not climb.⁸

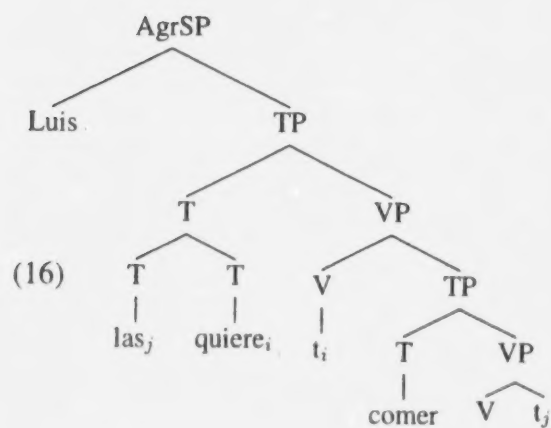
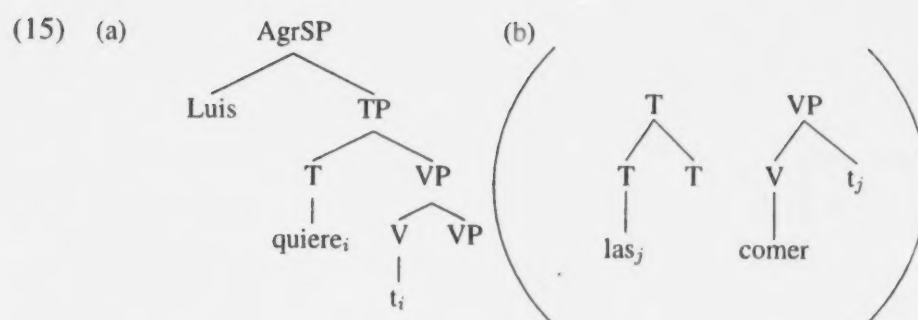
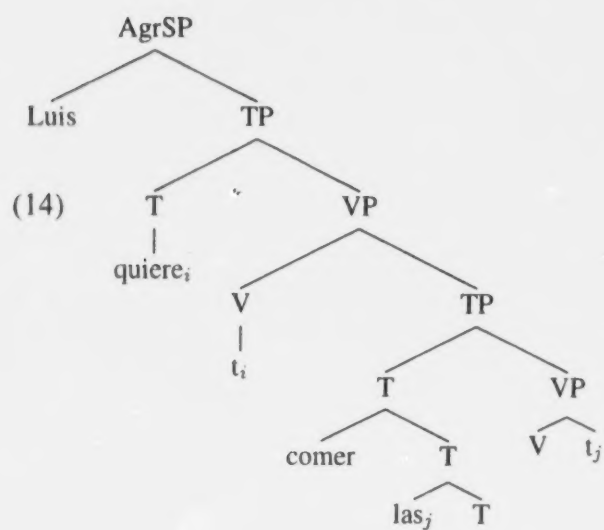
For example, (12a), without clitic climbing, is derived by (13b) substituting into the TP node of (13a), resulting in (14).⁹ Since (13b) projects up to TP, there is 'room' for the clitic, which remains attached in the lower clause.

For the clitic climbing case (12b), *quiere* takes a VP complement, as shown in (15a). Since the complement is only a VP, the clitic, which must attach to a T node, has nowhere to attach, and remains 'hanging'. The complement clause is therefore represented by a multi-component tree set, as in

⁷The other aspects of restructuring are not discussed. A quite different approach to clitic climbing in TAG has recently been proposed by Candito (1999). Space prevents discussion here, but it does not alter the main points of this paper.

⁸Support for this approach is given by the blocking of clitic climbing by negation, on the assumption that negation is located higher than the attachment site of the clitic. If the lower clause has negation, then it must therefore also have 'room' for the clitic to attach. Likewise, if the clitic climbs, then the complement clause is defective and does not have room for negation. See Moore (1991), Rosen (1990), Wurmbrand (1998) for further arguments for this view. Napoli (1981) discusses some complications for this view in Italian.

⁹For space reasons, there are some aspects of Bleam (1994)'s analysis that we cannot discuss here, such as the need for set-local MCTAG. Although important, they are not immediately relevant to the purpose of this paper.



(15b), in which one component is the clitic waiting to be attached, and the other component is the VP projection. The derivation proceeds by substituting the VP component of (15b) into the VP node of (15a), while the clitic component of (15b) adjoins into (15a) at the T node, resulting in (16), with the clitic having 'climbed'. Bleam (1994) assumes that the nonfinite verb moves (adjoins) to T when there is a TP projection, which is the case when there is no clitic climbing, as in (13b). In contrast, when the clause projects only to VP, the verb must stay at V, since there is no T head to adjoin to, as in (15b).¹⁰

4.2 Some Problems

An important technical aspect of Bleam (1994)'s analysis is that the clausal complementation is done by substitution, not adjoining. Substitution is used because the definition of multi-component TAG requires it. The derivation of (12b) just described uses a multi-component set (15b) in which one component (the VP component) substitutes in, while the other (the clitic) adjoins in. This is the scheme shown in (B) in Figure 3. If instead clausal complementation was done by adjoining, with the higher clause adjoining at the VP root of the lower *comer* tree, with the *las* tree adjoining into that higher clause, that would be the illegal scheme shown in (C) in Figure 3.

While clausal complementation can be done in TAG either by adjoining or substitution, adjoining must be used when part of the lower clause ends up in the higher clause, either through *wh*-movement or raising. This is because adjoining, but not substitution, allows the necessary 'stretching apart' of components of a tree. Bleam (1994)'s analysis, with the standard definition of TL-MCTAG, therefore makes the prediction that clitic climbing is impossible when the higher clause must adjoin, not substitute, and so clitic climbing should not occur when the higher verb is a raising verb.

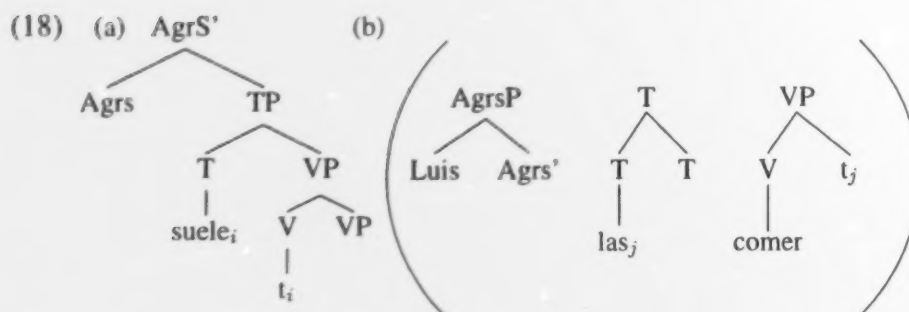
- (17) a. Luis suele comer *las*
 b. Luis *las* suele comer
 Luis them tends to eat
 'Luis tends to eat them'

To see why this is the case, consider sentence (17b), which shows a clitic climbing to a higher trigger verb which is also a raising verb (Aissen and

¹⁰ An issue raised by this analysis is the status of PRO in the complement, which is obscured by the fact that [Spec, VP] is not shown, although presumably PRO should be there. This problem is not unique to the Bleam (1994)'s TAG analysis, since every analysis taking a VP complement must say something concerning this. We return to this issue later.



Figure 4: Clitic-Climbing with a Raising Verb

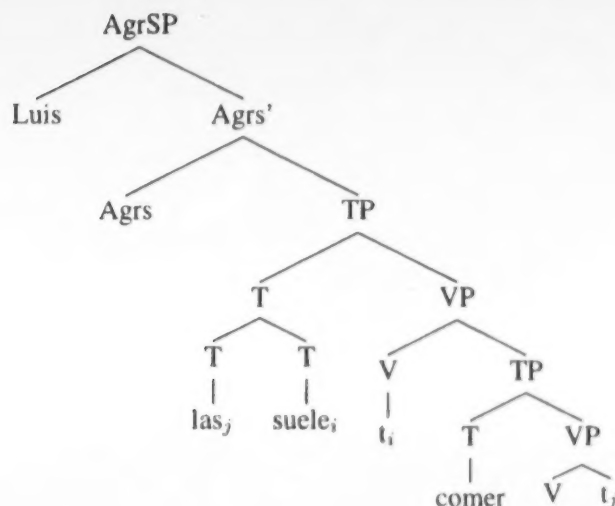


Perlmutter (1983)). Since *suele* allows clitic-climbing, it is presumably taking a VP complement in (17b). But since it is also a raising verb, the subject of the sentence, *Luis*, is part of the *comer* tree (or tree set). Without worrying here about the details of where exactly *suele* might be adjoining, the derivation would be as roughly illustrated in Figure 4. As the figure shows, *comer* and *las* are part of a multicomponent tree set, and *las* adjoins into the raising verb, *suele*, which is itself adjoining into the other component of the tree set, *Luis comer*.

However, this is exactly the derivation structure which is ruled out by tree-local multi-component TAG, as in Figure 3C. Therefore, Bleam (1994)'s analysis, using tree-local multi-component TAG, predicts that such a case will not occur, although in fact cases such as (17b) are indeed acceptable (the same is true for Italian).

One possibility which seems reasonable is that the derivation could be handled by using a tree set for the *comer* clause as in (18b). The derivation would proceed by the *comer* component of (18b) substituting into the VP node

(19)



of (18a), while the *las* component of (18b) adjoins at the T node of (18a), with the AgrS' component of (18b) fitting 'on top' of (18a), resulting in (19). This last step is however again a technical difficulty for TAG.

However, the intuition behind this approach is essentially correct, we think, and the rest of the paper can be viewed as working out of this intuition, and linking it to other problems that have been identified for basic TAG.

An examination of this example also points out an interesting issue concerning the idea of trigger verbs taking 'defective complements'. Consider again example (17b). By Bleam (1994)'s analysis, the clitic climbs when the lower clause is defective, missing a tense projection. However, while it is missing the tense projection in (17b), it must at the same time also have a [Spec, AgrSP] projection. If the VP projection substitutes into the higher tree, then it must be the root of the tree that gets substituted in, and so the AgrSP projection with *Luis* would have to be a separate tree in a tree set, perhaps an undesirable move. For example, this is the case in (18b), but the need to represent the AgrSP projection as a separate tree is clearly an artifact of the handling of clitic-climbing, and it would be more desirable to represent the AgrSP projection in the same way as in other clauses.

The same issues arise for the case of clitic climbing with wh-movement, the other case which requires clausal complementation by adjoining. To test this case, we need a case of a clitic climbing to a higher verb, while another argument is extracted. This cannot be tested with a lower verb that takes only one argument, since if that argument is cliticized, then it cannot also be extracted as a wh-phrase. However, it can be tested with a lower verb that takes

two NP arguments, as in the following examples:

- (20) a. Juan quiere mostrartelos
 Juan wants to show them to you
 b. Juan *telos* quiere mostrar
- (21) a. Que quiere mostrarte Juan
 What want to-show-to-you Juan
 'What did Juan want to show to you?'
 b. Que *te* quiere mostrar Juan
- (22) a. A quien quiere mostrarlos Juan
 To-whom want to-show-them Juan
 'To whom did Juan want to show them?'
 b. A quien *los* quiere mostrar Juan

(20a) has a lower verb with two argument clitics, and both can climb to the higher verb, as shown in (20b). The object argument can be wh-moved, as shown in (21a), and, crucially, even with this extraction the dative clitic can climb to the higher verb (21b). This last sentence is therefore a problem for Bleam (1994)'s analysis. Similarly, the accusative clitic can climb to the higher verb, while the indirect-object is wh-moved, as in (22ab).¹¹ Note that in (21) and (22), in which the complement is supposedly 'defective', it seems to project up to a [Spec, CP] position.

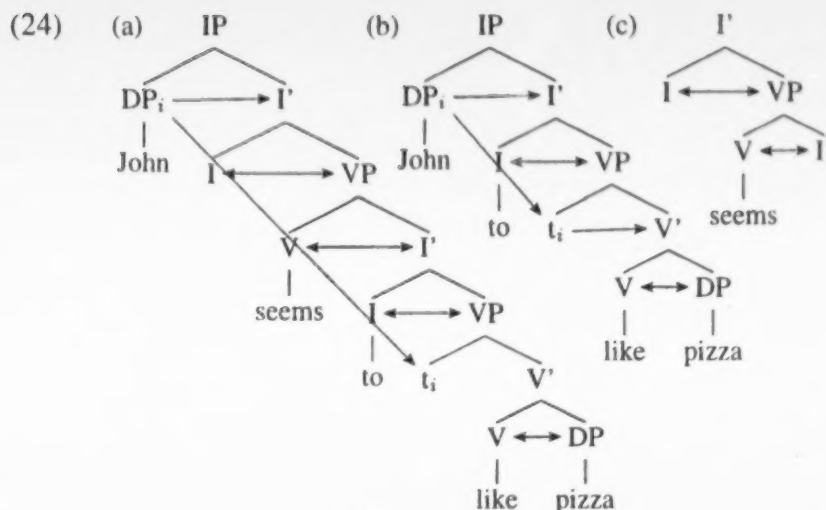
We are therefore left with two related problems:

- There are cases in which the 'defective complement' has material (such as the subject or wh-item) which ends up above the root of the higher clause. This causes a problem for the definition of TL-MCTAG.
- What does it mean for the complement to be 'defective', if in fact it does project higher up, to include a subject or wh-item?

¹¹An analogous point for multi-component TAG and long distance scrambling in German with extraction was made earlier by Rambow (1994).

Also, the same is true for the analogous Italian examples:

- (i) a. Piero voleva spedirmelo
 Piero wanted to send it to me
 b. Piero *melo* voleva spedir
 c. Cosa voleva spedirmi
 what he wanted to send to me
 What did he want to send to me?
 d. Cosa *mi* voleva spedire?



5 TAG Derivation as C-command

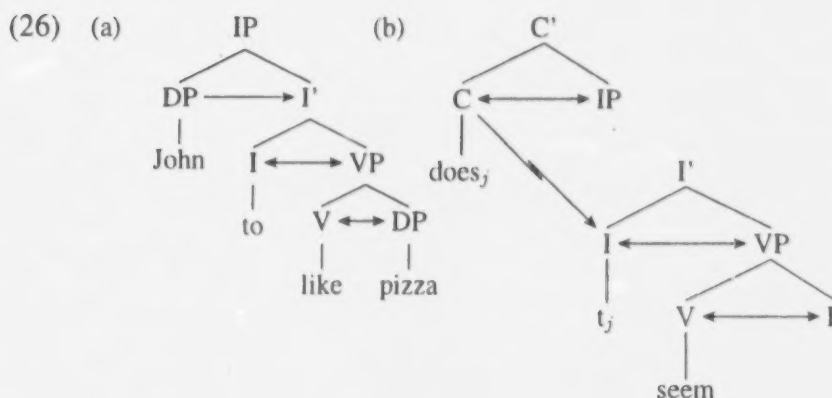
In this section we give a brief summary of the approach to TAG derivations taken in Frank and Vijay-Shanker (1998), Frank et al. (1999). This approach argues for a reconceptualization of the TAG formalism, in which the elementary structures are collections of c-command relations, and the sole combinatory operation is substitution, with adjoining eliminated. Here we give an illustration of how this approach solves one problem for TAG, and in the next section we discuss how this same approach solves some of the problems presented by the data in the previous section.

A TAG elementary tree is viewed as a collection of c-command relations determined by (at least) the following principles (cf. the definitions in Kayne (1994)):

- (23) a. A moved element c-commands its trace
 b. A head and its complement c-command one another
 c. A modifier c-commands the phrase it modifies
 d. A specifier c-commands the phrase to which it attaches

For example, the raising case (11) is reinterpreted by viewing the elementary trees (11a-c) as the collections of c-command relations (24a-c), where the arrows indicate the c-command relations.¹²

¹²The lines indicating direct domination are not intended as part of the representation, but rather as an aid to the reader in comparing the proposed structure to that



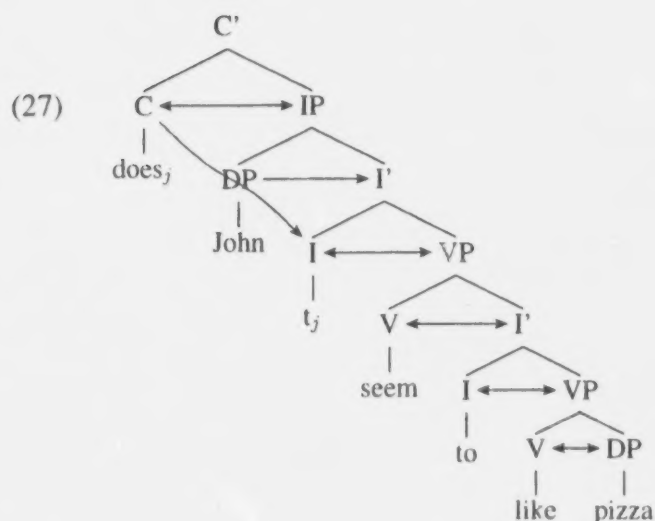
The derivation is a monotonic combination of the c-command relations, and proceeds by substituting the I' node of (24b) into the bottom I' node of (24c) (the *substitution node*). Maintaining the c-command relations results in (24a). One way to view this use of substitution is that *to like pizza* substitutes into the *seems* tree, with *John* 'floating' up to its final resting place.

5.1 Solving a Long-standing Problem for TAG

(25) Does John seem to like pizza?

One long-standing problem for TAG has been the interaction of raising and subject-auxiliary inversion, as in (25). By the CETM, *does* should originate in the same elementary tree as *seem*. However, since the raising auxiliary tree adjoins to the I' node, there is no way to include the auxiliary verb *does* within the *seems* tree so that it ends up in a position preceding the subject DP in the final sentence. That is, adjoining at I' 'stretches' *John* away from the *to like pizza*, but without allowing the 'interleaving' necessary to form (25).¹³ The c-command approach allows a resolution of this problem, by using the standardly assumed. Certain implicit c-command relations, such as that between I and constituents of VP, are suppressed in this figure, but are assumed to be present. See Frank and Vijay-Shanker (1998) for extensive discussion of the properties of structures defined in terms of c-command and the relationship between such structures and those defined in terms of dominance.

¹³It may be possible to handle this *do*-support example by other means, such as treating the auxiliary and raising verbs as separate trees, not members of a tree set. However, the same problem extends to examples of raising/*wh* interaction such as (ib), in which the experiencer of *seems* is extracted to the [Spec, CP] position. Here there is



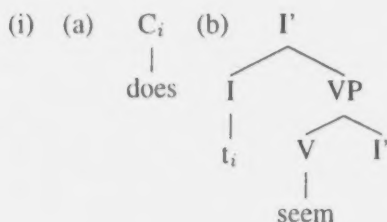
collections of c-command relations in (26ab). The structure for *like* in (26a) is the same as (24b). For the *does/seem* structure in (26b), however, *does* is shown as having raised to the C node, which therefore c-commands the I node.¹⁴

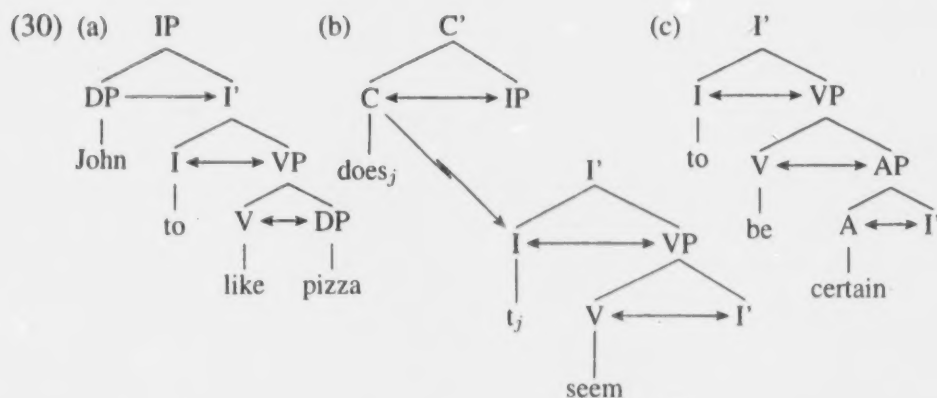
The derivation proceeds by substituting the I' node of (26a) into the bot-

no choice but to say that *to whom* and *seem* in (ib) are members of the same elementary structure, whether a tree set or a set of c-command relations. The solution argued for here for (25) also extends to (ib).

- (i) a. John seems to Bill to be crazy
 b. To whom_i does John seem t_i to be crazy

¹⁴Frank (1992) had previously proposed utilizing TL-MCTAG to solve this problem, using the tree set in (i). The c-command approach allows a cleaner representation of this solution.





tom I' node of (26b). In the resulting structure, the *does* and *John* fragments must both c-command I', and so (27) is consistent with maintaining the c-command relations, and gives the desired derivation.

However, the substitution of *to like pizza* into the lower I' node of *seems* does not in fact fully determine the result shown in (27). The relative c-command relation of *does* and *John* is not determined—all that is known is that they both must c-command the I' node headed by the trace of *does*. However, if the IP that is the complement of the C node headed by *does* is the same as the IP parent of *John*, then the result must be as shown, with the inversion forced. The intuition is that there cannot be two IP nodes among the 'floating' components, where the *John* and *does* segments can be considered 'floating'. Condition (28) was therefore proposed in Frank et al. (1999), with a precise characterization of 'floating components' left open.

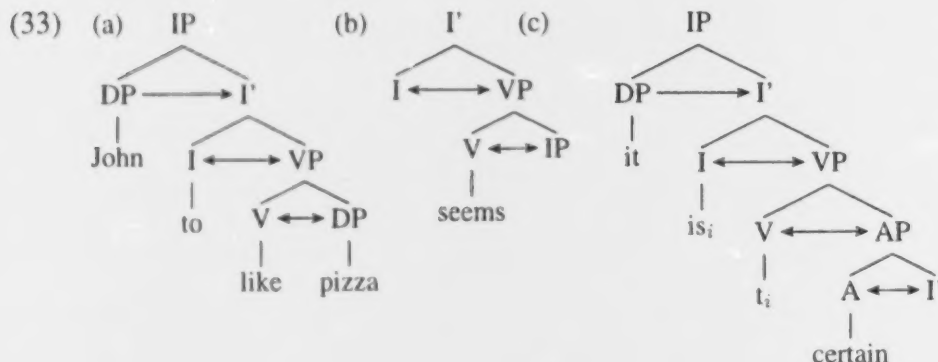
- (28) Derivational CETM: The floating components of a derivation may constitute exactly one extended projection.

5.2 Unboundedness

Certain issues arise when multiple levels of embedding are considered, as in (29). The elementary structure headed by *certain* would be (30c), with the *like* and *does/seem* structures in (30ab) the same as before.

- (29) Does John seem to be certain to like pizza?

There are a number of ways this derivation could proceed. For example, (30b) and (30c) could combine first, or (30a) and (30b) could combine



first. Only one of these derivations was allowed in Frank et al. (1999), by the proposed condition on derivations (31):

- (31) The structure containing the substitution node must be elementary (that is, not the product of a derivation).

With this constraint, the derivation must proceed by substituting the I' node of (30a) into the bottom I' node of (30c), resulting in a structure for *John to be certain to like pizza*. The final step in the derivation substitutes the upper I' node from this structure (*to be certain to like pizza*) into the bottom I' node of (30b), resulting in the desired derivation. This derivation can be viewed as allowing *John* to 'float up' past the *certain* and *seem* clauses.

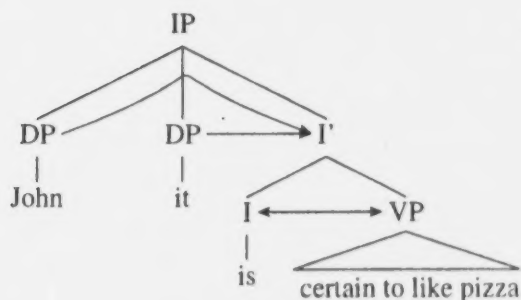
5.3 Locality Constraints

As just described, the recharacterization of TAG as c-command relations allows components of an elementary structure to be viewed as 'floating' up through the derivation. It is important, however, that such components not be allowed to float 'too far'. For example, consider a 'superraising' case, as in (32).

- (32) * John seems it is certain to like pizza

The derivation could proceed by substituting the I' node of (26a), repeated here as (33a), into the bottom foot node of (33c), allowing *John* to 'float up'. At this point in the derivation, there will be two floating items, both specifiers for IP (*John* and *it*), with no c-command relations between them. The derivational CETM therefore applies, forcing these two IP nodes be identified, since

(34)



otherwise it would constitute two distinct extended projections. The resulting structure is therefore as shown in (34).

John is prevented from floating too far by the application of the derivational CETM, which forces the IP node of *John* to be identified with the IP node of *it*, thus causing an illegal configuration.¹⁵

6 Fixing the Problems

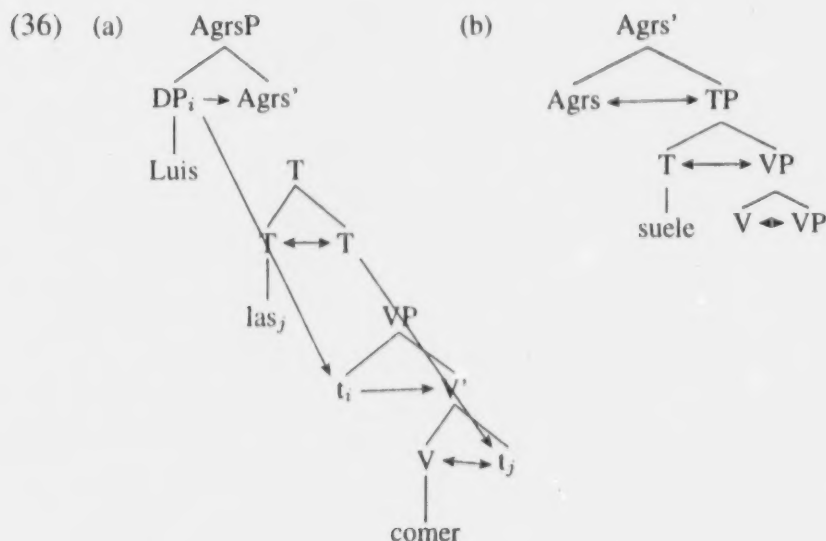
6.1 The Basic Case: Optional Clitic Climbing with One Trigger Verb

Adopting the TAG-as-c-command approach described in the previous section allows the derivation of the problematic cases, as we illustrate with the raising case (17b), repeated here as (35b).

- (35) a. Luis suele comerlas
 b. Luis *las* suele comer
 Luis them tends to eat
 'Luis tends to eat them'

A possible derivation is shown in (36). The structure for the *comer* clause is shown in (36a). The subject, *Luis*, has moved to [Spec, AgrsP], and thus must c-command [Spec, VP], as shown, although the TP projection is not projected in (36a). The clitic *las* is shown as having moved from the object position, and thus must c-command its trace. In addition, the representation shows that it must adjoin to a T projection, although there isn't one in the *comer* clause (and so also the verb stays at the V node). The raising verb

¹⁵There are different ways of ruling this an illegal configuration, although the most obvious are a violation of the extended projection principle or of lack of Case for both NPs.



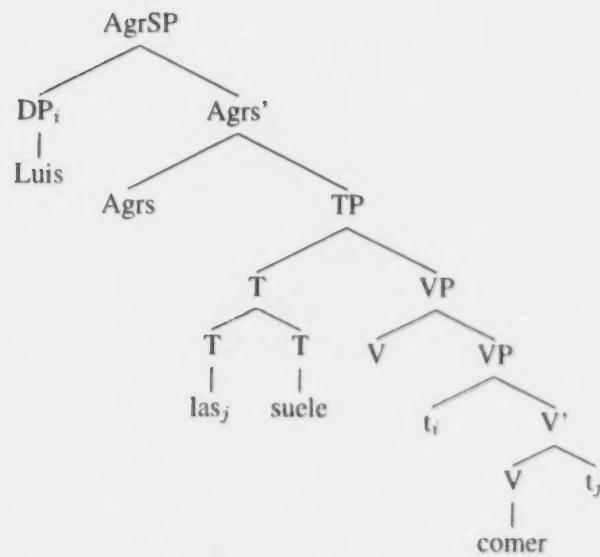
takes a VP complement, as in (36b).¹⁶ The derivation proceeds by the VP node of (36a) substituting into the bottom VP node of (36b). Maintaining the c-command relations gives the result in (37), with *las* attached to the T node for *suele*, as desired. To avoid clutter, we have not explicitly shown the c-command relations in (37).

This derivation maintains the basic idea of Bleam (1994)'s approach, in which the trigger verb can optionally take a VP complement, getting the clitic when it does so. The use of substitution together with identification of the 'floating components' solves the problem of how the *comer* clause projects 'up to' AgrsP without including a TP projection, by using the c-command relations to allow *Luis* to raise to [Spec, AgrsP], without TP being specified at all, while still allowing substitution of the VP node into the *suele* clause.

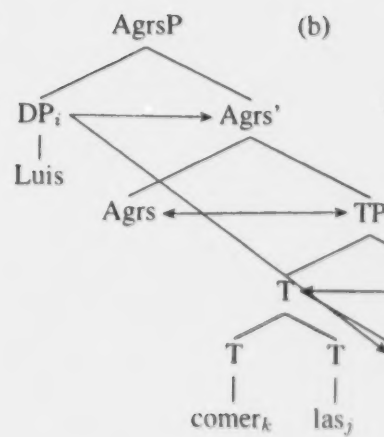
Before discussing further the issues raised by this approach, we illustrate the derivation with no clitic climbing. The tree for the lower clause in the case of no clitic climbing is shown in (38a). In this case, the lower clause projects the tense projection, the verb moves to the T node, and the clitic attaches. We assume that the trigger raising verb takes an AgrS' foot node, as in (38b), when there is no clitic climbing. The derivation proceeds by the AgrS' node of (38a) substituting into the bottom AgrS' node of (38b), resulting in (39).

¹⁶Since the *suele* clause does not select for a subject, neither [Spec, TP] nor [Spec, VP] are projected. Thus, there is no difference between TP and T', or VP and V', and so the intermediate projections have been eliminated.

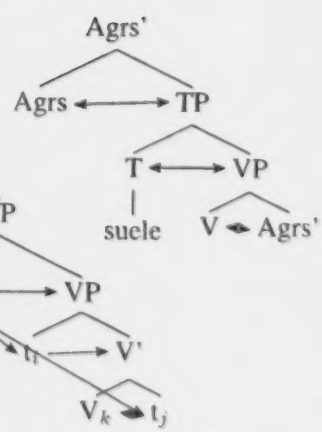
(37)

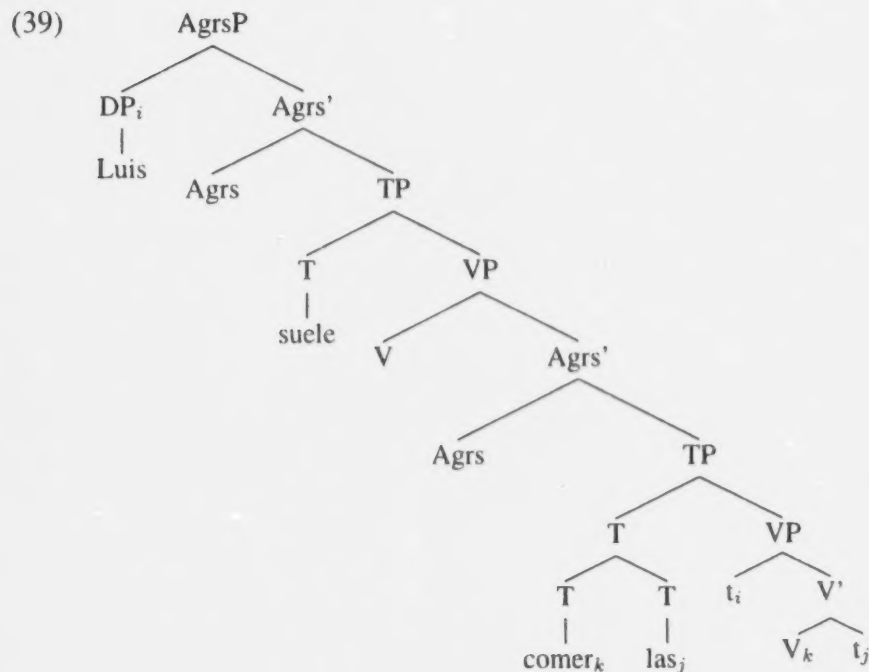


(38) (a)



(b)





6.2 Handling the Unboundedness of Clitic Climbing

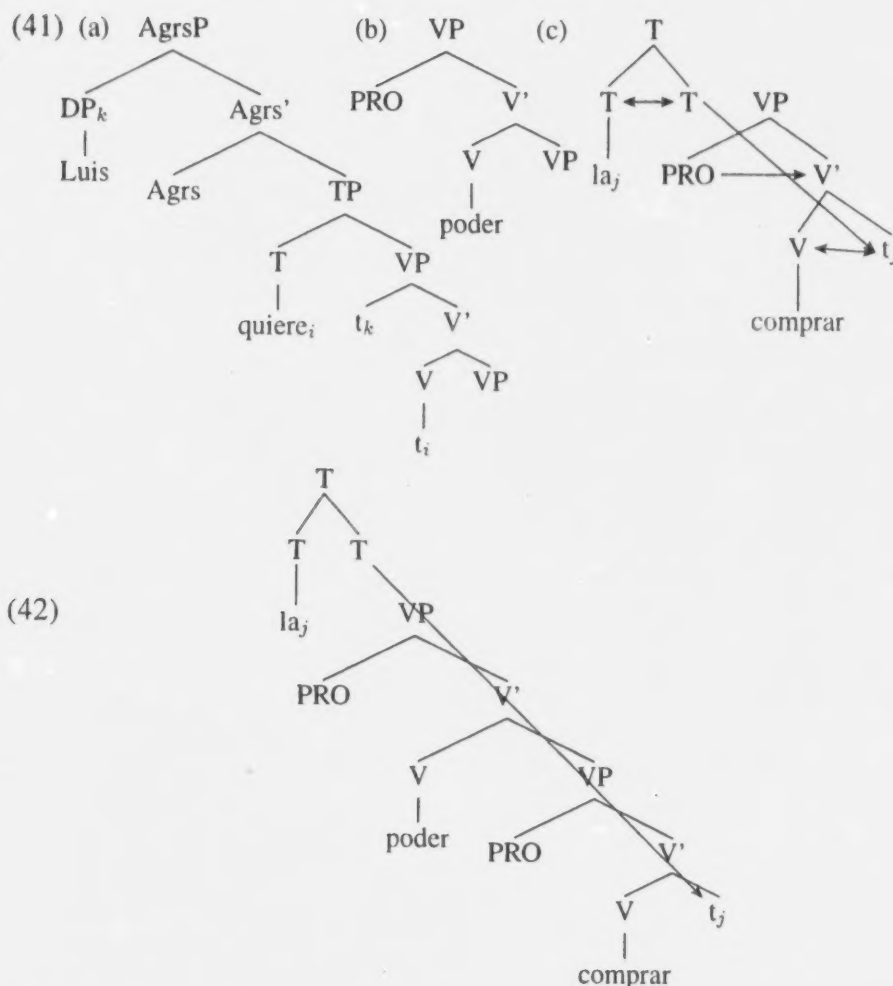
For a somewhat more complicated example, consider how the unboundedness of clitic climbing can be accounted for. Sentence (8), repeated here as (40), is a case of a clitic climbing over two trigger verbs, *quiere* and *poder*. Both of these trigger verbs are control verbs,¹⁷ and so the structure of the derivation is somewhat different from that with the raising trigger verb *suele*.

- (40) Juan *la* quiere poder comprar
 Juan it wants to be able to buy
 'Juan wants to be able to buy it'

Just as in Bleam (1994)'s analysis, *quiere* (41a) heads a clause that is taking a VP complement. The clauses for *poder* (41b) and *comprar* (41c) both project to VP, thus forcing the clitic to climb.

Following the restriction (31) on derivations discussed earlier, the derivation proceeds by substituting the VP node of (41c) into the bottom VP node of

¹⁷Actually, it's not so clear that *poder* is a control verb, and there is also some evidence that in Spanish *quiere* should be treated as a raising verb. We leave this issue aside for now, and assume that these are control verbs.



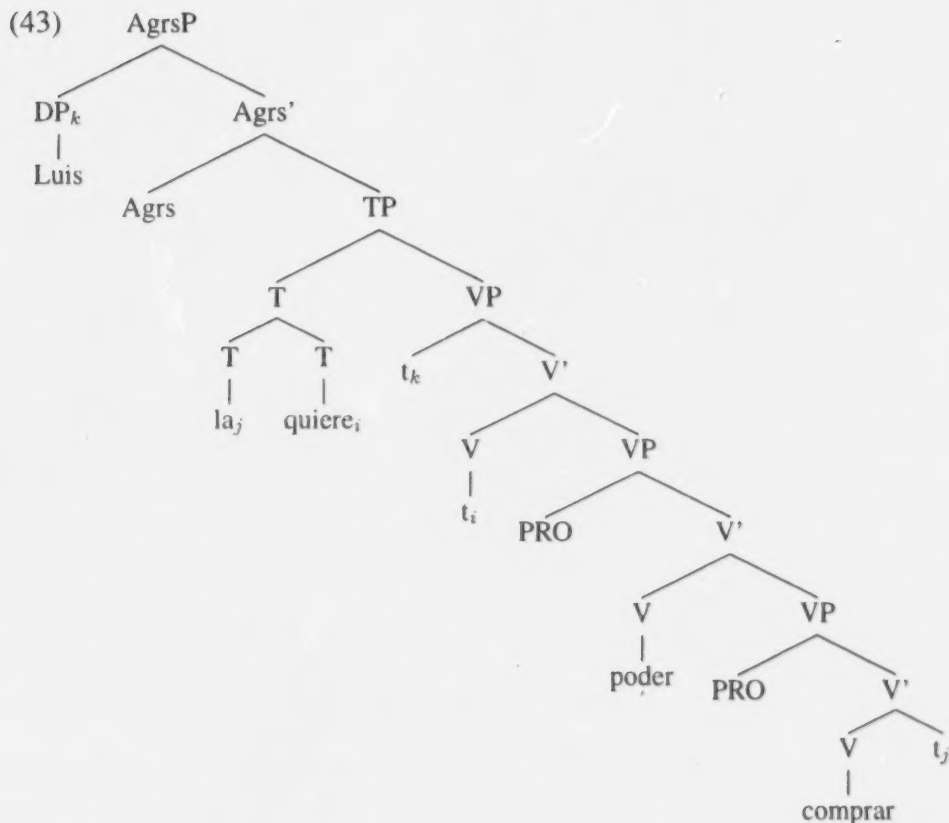
(41b), resulting in (42).

Since there is no T projection in (42), the clitic is left 'floating'. The top VP node of (42) is then substituted into the bottom VP node of (41a), resulting in (43), with the clitic then able to attach to the T node of the *quiere* clause.

6.3 Floating Components and Identified Extended Projections

Recall that in the c-command approach, a 'Derivational CETM' (DCETM) (28) was put forward as a way to control the movement of the 'floating' components, while leaving vague the definition of the floating components, although the intuitive sense was hopefully apparent. The DCETM was shown in Section 5 to have two effects in the examples discussed there:

- In the derivation (26) of *Does John seem to like pizza?*, after *to like pizza*



substitutes into *seems*, the two floating components are *John* and *does*, both of which refer to an IP projection. By the DCETM, the two IP projections must be identified, thereby fixing the order of *does* and *John*.

- In the potential derivation (33) of the unacceptable super-raising case (32), after *is certain* and *to like pizza* combine, *John* and *it* are the two floating components. Since they both refer to an IP projection (both being specifiers of IP), and both are 'floating', by the DCETM they must both be specifiers of the same IP, resulting in the invalid (for independent reasons) structure (34).

As the super-raising case in particular shows, these conditions on attachment are very reminiscent of the 'shortest move' type of restrictions from work in the Minimalist framework. The clitics in effect need to attach to a T node as soon as there is a T node to attach to, just as the floating *John* had to attach to an IP node as soon as one was available in the derivation of the superraising

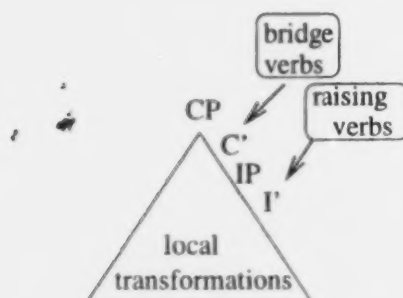


Figure 5: Capturing Different Types of Inter-Clausal Movement in TAG

case (32), thus preventing it from floating 'too far'. It would be disappointing, however, if such a 'shortest move' restriction had to be imposed in a TAG framework, since one of the claims of work in this framework (e.g., Frank and Kroch (1995)), is that by utilizing clause-sized elementary structures instead of the single-level items taken from the 'numeration', such stipulations as 'shortest move' can be eliminated. It is therefore quite nice that the DCETM, by 'identifying' the nodes of the 'floating' components, accomplishes the same effect (at least in the examples under discussion here).

While there are different ways that one might characterize the 'floating elements', in the next section I will suggest that by reintroducing the crucial place of recursive structures in the framework, we can give a relatively simple characterization of 'floating components', one that is completely natural for the TAG approach. We also discuss how this accounts for further locality issues with clitic climbing.

7 Recursive Structures and 'Floating Elements'

Consider again how *wh*-movement and subject-to-subject raising are handled in TAG, as discussed in Section 3. The bridge verbs adjoin in as C' recursive structures. Since the *wh*-moved items are at [Spec, CP], they are high enough to be 'stretched away' by the bridge verb adjoining in. Similarly, subjects in [Spec, IP] get 'stretched away' by the raising verb adjoining in as an I' recursive structure. Since the raising verb adjoins low, the subject doesn't have to move as high as the *wh*-item.¹⁸ Although these standard examples of

¹⁸Indeed, aside from [Spec, VP] to [Spec, IP], if the VP-internal-subject-hypothesis is adopted, it doesn't have to move at all.

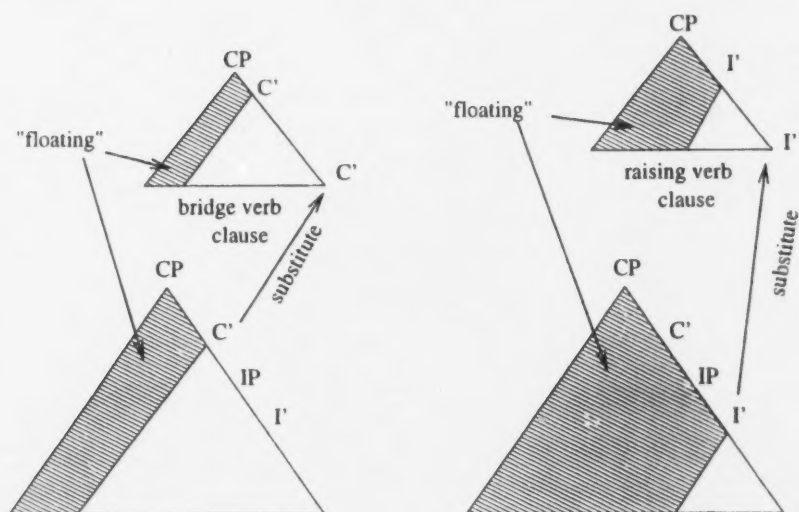


Figure 6: Inter-Clausal Movement in TAG, Revised

A' and A inter-clausal movement have quite different properties, in TAG they are handled by the same mechanism, adjoining, with the differences in their properties arising from the different loci of adjoining. The picture therefore looks roughly like that in Figure 5, which illustrates the schema of the bridge and raising verbs adjoining in.

However, the discussion of the *does/seem* case (25) shows that even for the raising case, this picture is not fully accurate. The higher clause *seems* does not consist only of a recursive I' structure, but also of some structure above the I' node, namely *does*. This suggests a way to characterize what the 'floating elements' are in the c-command recharacterization of TAG. While space prevents going into the technical details, the basic idea is to bring back into this framework the fundamental place of recursive structures.

A review of the examples discussed so far shows that in cases of 'floating elements', the higher clause (that the lower clause substitutes into) has a recursive component, and additional elements that c-command the top of that recursive component that are subject to the DCETM. The elements that c-command the substitution site in the lower clause are also subject to the DCETM.

For example, the *does...seem* clause (26b) for *Does John seem to like pizza* (25) has an I'-recursive component. The element c-commanding the recursive part of the *seems* clause (that is, *does*) is considered 'floating' and subject to the DCETM. The element c-commanding the substitution site I' in the *like* clause (26a) is also considered 'floating' and subject to the DCETM.

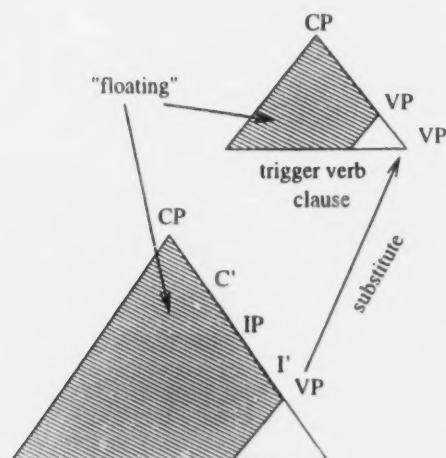


Figure 7: Trigger (Clitic-Climbing) Verbs

The DCETM causes The IP nodes for these two floating elements to be identified. The 'floating' components are therefore the part of the higher clause that c-commands the higher recursive node, and the part of the lower clause that c-commands the node that gets substituted into the higher clause. Similarly, for the superraising case (32), the *it is certain* clause (33c) has an I' recursive part, with only *it* c-commanding the recursive part, and so *it* was considered one of the 'floating' elements.

The revised picture is shown in Figure 6. Note that the importance of the 'floating' component of the higher clause is obscured by looking at the bridge verb case because there is no room for any structure above the C' node to be floating, because all that's left is the [Spec, CP] node. The importance of the *does/seem* case is that shows how there must be stuff above the recursive component that 'merges' in.

There may in fact be some advantages in redefining the notion of derivation to explicitly use the notion of adjoining plus 'identifying' the nodes in the floating components, although that cannot be discussed here. While the exact details of how those floating components are unified can be handled in a number of different ways, the important point is the overall structure of the derivation, and how the 'Derivational CETM' results in the desired constraints on movement.

7.1 Clitics and Locality

Now, consider again the place of clitic climbing with the 'trigger verbs' in this context. A look at the derivations in the previous section shows that they all have a VP recursive part, with some (but not all), having additional material above. So along with the 'defective complements' for raising and bridge verbs with the corresponding 'floating material', we have the picture in Figure 7.

For example, in the derivation for *Luis suele las comer* (36), the *suele* clause (36b) has a VP recursive component into which substitutes the VP node of the *Luis las comer* clause (36a). In order for the clitic to be 'floating', it just has to be specified that T c-commands not only the trace of the clitic, but also the VP node as well. Similarly, *Luis* in (36a) must be 'floating' as well, since it c-commands the substitution site, VP. In (36b), all the material c-commanding the VP recursive structure is 'floating'; namely, *Agrs* and *suele*, as desired. The identification of nodes in the floating components gives the desired result. In the case without clitic climbing (38a), since the higher clause is simply an *Agrs*' recursive structure, the locus of substitution, *Agrs*', c-commands the clitic, and so the clitic is not floating.¹⁹

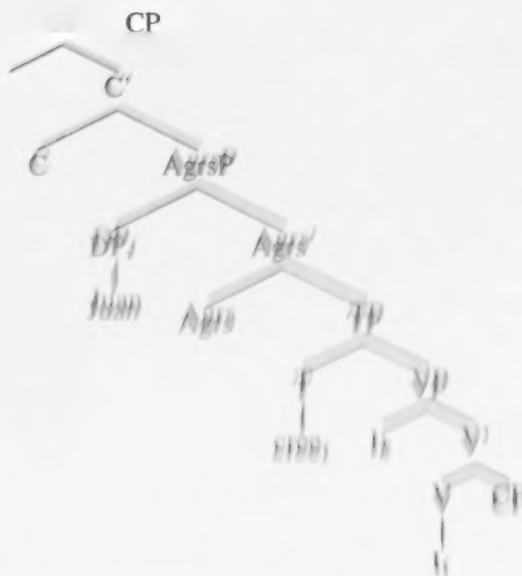
- (44) a. Juan cree que Luis quiere comprarla
 Juan believes that Luis wants to buy it
 Juan believes that Luis wants to buy it
 b. Juan cree que Luis *la* quiere comprar
 c. * Juan *la* cree que Luis quiere comprar

We now consider some issues regarding how far the clitics can 'float', and how it is handled by the scheme just discussed. While the derivation in the previous section allows the clitic to 'float' up to derive the clitic-climbing case, we do not want to allow the clitic to float 'too far'. For example, suppose that *las* in (37) does not attach to *suele*, but rather remains 'floating'. It could then continue to float up to a higher clause, perhaps one headed by non-trigger verb, which would not be acceptable. A case of this type is (44c), in which the clitic *la* has moved past the *quiere* clause.

Consider first the derivation of the acceptable (44b). Since the clitic climbs to the *quiere* clause, this means that the *quiere* clause takes a VP complement. The *quiere* clause, (46a), is therefore the same as (41a), except that it also includes a CP node with *que* in the complementizer position. The *cree* clause (45) of course takes a CP complement.

¹⁹Also, if in (38a) the clitic and verb are in a mutual c-command relation, then the clitic could not move up without disrupting the c-command relations, thus violating the required monotonicity of the derivation.

(45)



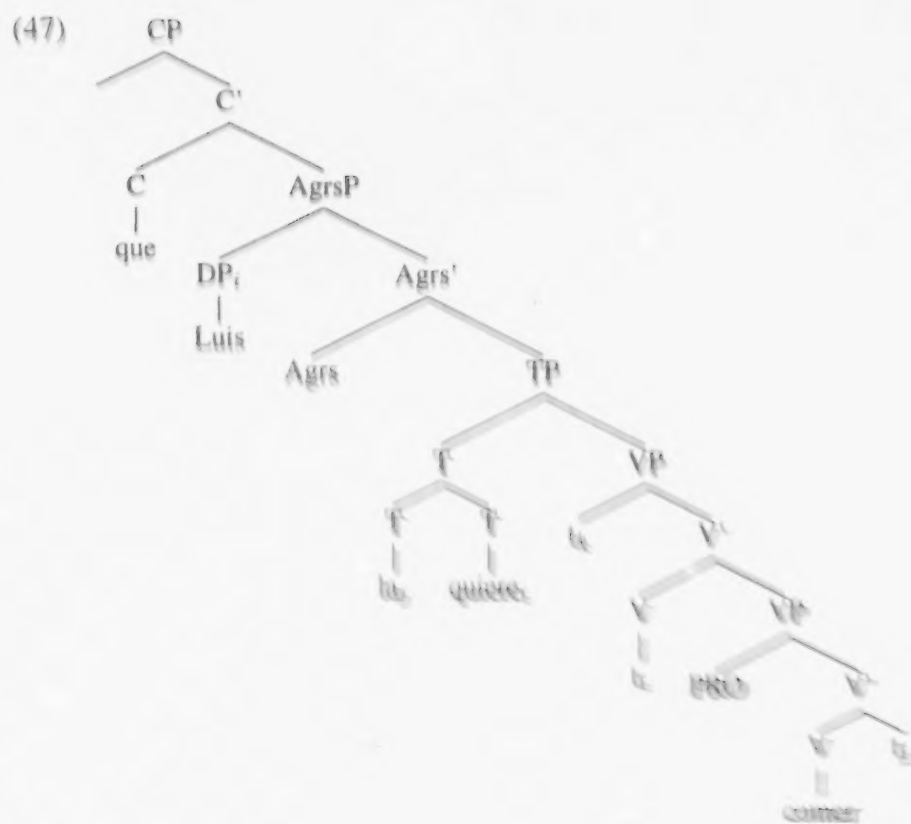
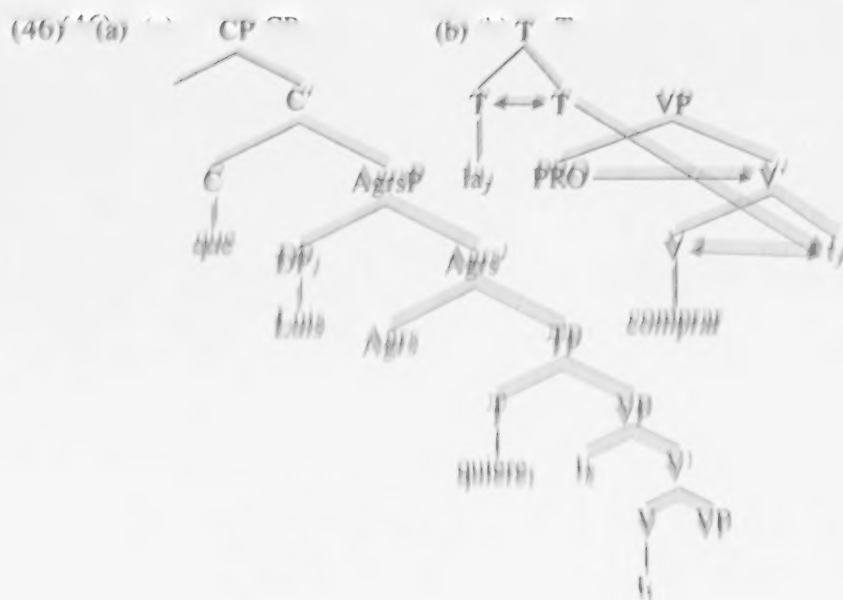
The derivation proceeds by substituting the VP node of (46b) into the lower VP node of (46a). The 'floating components' are therefore the clitic in (46b) and the structure c-commanding the higher VP in (46a). The T nodes of *quiere* and *la* are therefore identified, resulting in structure (47). Then (47) substitutes into the CP node of (45). Since there is no structure c-commanding the CP node of (47), there is no material to 'float', and the clitic cannot climb any further, and so (44b) cannot be derived.

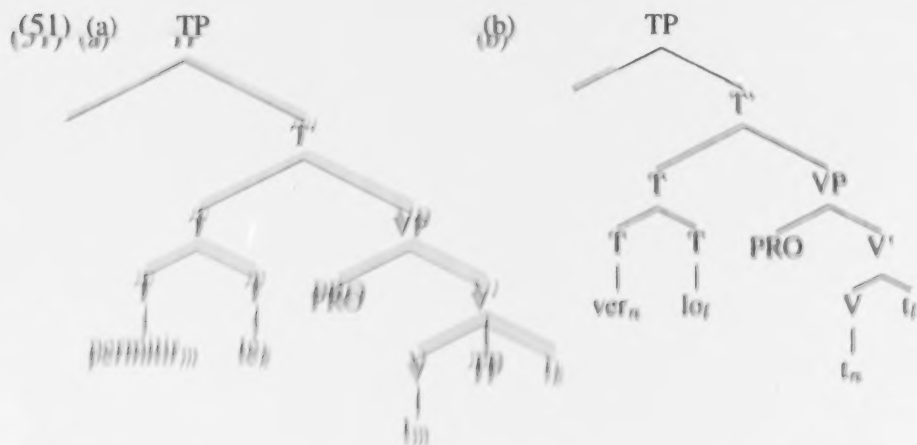
7.2 Intersecting Clitic Climbing

One interesting case of restrictions on clitic movement is what Aissen and Perlmutter (1983) referred to as 'intersecting clitic climbing'. In all of the examples discussed so far, the trigger verbs are either raising or subject-control verbs. In Spanish, however, there are also some object-control verbs which allow clitic climbing, such as *permitir*, as in (48ab).²⁶

- (48) a. Juan le permitió arreglarla (a Pedro)
 Juan allowed Pedro to repair it
 b. Juan se le permitió arreglar (a Pedro)

²⁶The *le*-clitic in (48a) is changed to *se* when it appears with *la*, the 'spurious *se*' rule. This does not matter for our purposes here.





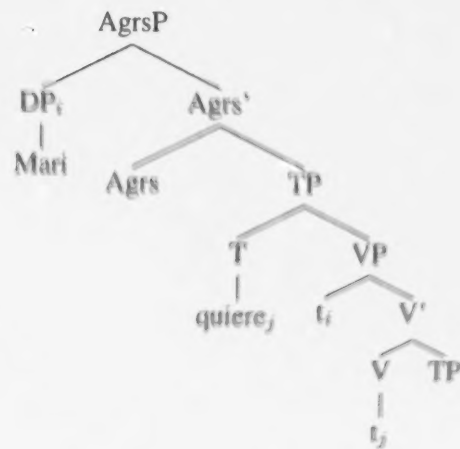
We now show how this falls out of the structure of a derivation as discussed so far. The case with no clitic climbing, (49a), is straightforward. Both *quiere* and *permitir* take complements that are 'bigger' than just VP projections. Most likely these are CP projections, but to avoid clutter we will just show them as TP projections, although it doesn't matter for present purposes. The point is that the complement is 'non-defective'-enough so that the clitics do not climb. To derive (49a), therefore, the structures in (50) and (51) are used, with (51b) substituting into (51a), with the result substituting into (50).

To derive (49b), the *ver* clause must be a VP, so that the clitic is forced to climb. At the same time, the clitic *te* from the *permitir* clause does not climb, and so the *permitir* clause is a TP clause. Therefore the structures in (52) and (53) are used. The VP node of (53b) substitutes into the bottom VP node of (53a). At that point the *lo* clitic and the structure above the higher VP node in (53a) are 'unified'—that is, the T nodes are identified, and so the clitic structure *lo* must attach to the *te* *permitir* structure. The clitics are both now 'stuck' on *permitir*.

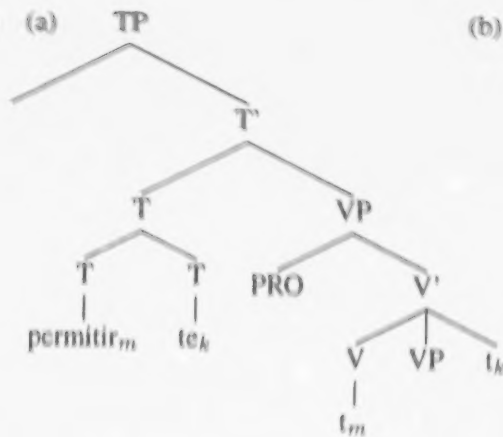
Similarly, to derive (49c), the structures in (54) and (55) are used, in which both *permitir* and *ver* project only to VP. As is hopefully clear, this forces both clitics to climb to the *quiere* clause.

Now consider the unacceptable cases (49d). For (49d), since *te* climbs from the *permitir* to the *quiere* clause, then the *permitir* clause must project only to VP with *quiere* taking a VP complement. Since *lo* climbs from the *ver* clause to the *permitir* clause, it must project only to VP, and the *permitir* clause takes a VP complement. But then this are the same structures as used to derive (49c), and so (49d) cannot be derived.

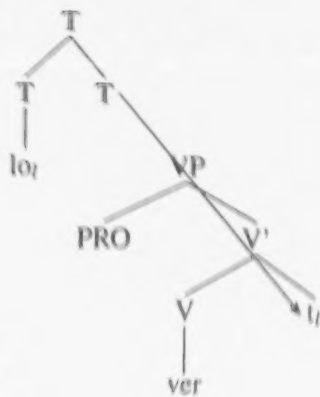
(52)



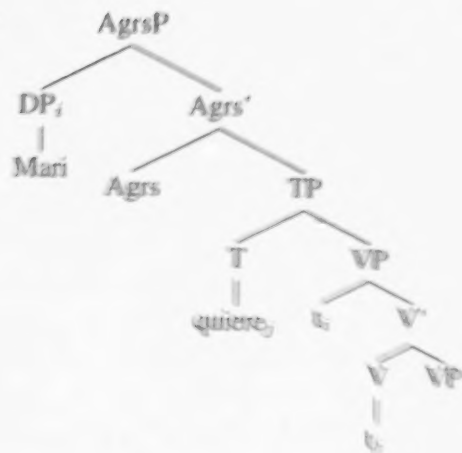
(53) (a)

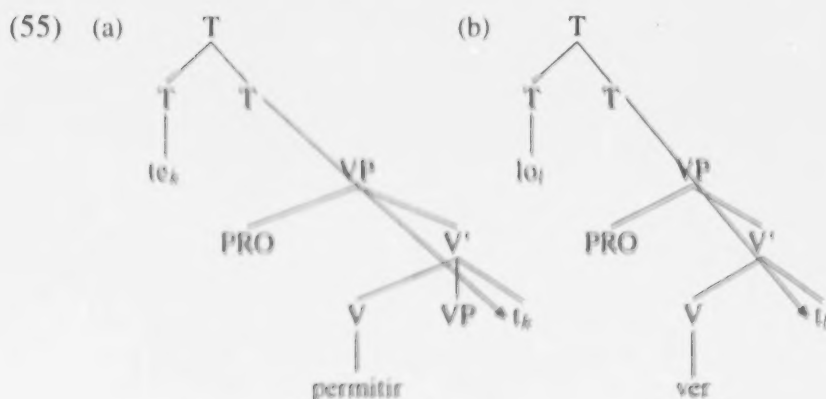


(b)



(54)





For (49e), since *te* does not climb out of the *permitir* clause, the *permitir* clause must project higher than VP, TP in this example. Since *lo* climbs out of the *ver* clause, the latter must only project to VP. Therefore the *permitir* clause is (53a), and the *ver* clause is (53b)). These are the same structures used to derive (49b), and so (49e) cannot be derived. Once the VP node of (53b) substitutes into the bottom VP node of (53a), the T nodes are 'identified', and *lo* is attached to *permitir te*.²³

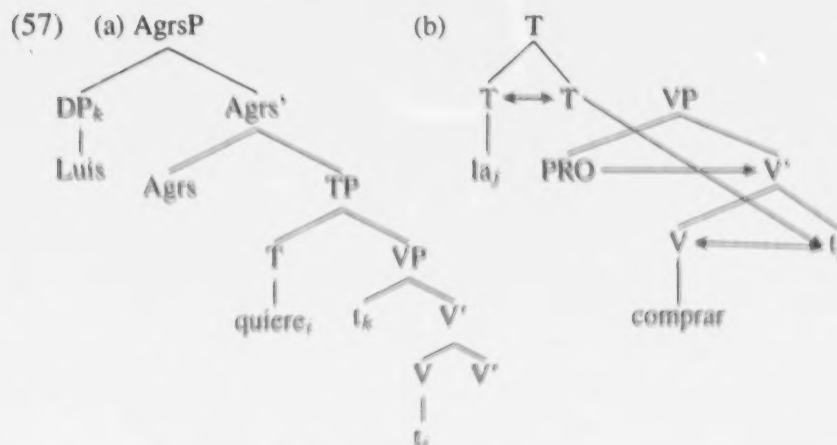
In short, the use of the Derivational CETM, forcing the 'floating components' to be identified, allows the desired locality constraints to be preserved. Again, it is accomplishing the same effect as a 'shortest move' type constraint.²⁴

²³For space reasons, we have left out one additional case, (i), in which the middle clitic climbs to the highest clause, while the lowest clitic remains with the lowest clause.

- (i) Mari *te*_i quiere [permitir *t*_i [ver *lo*]]
 NOM1 DAT2_i V1 [V2 *t*_i [V3 ACC3]]

This is acceptable, and can be derived without a problem. The *quiere* clause takes a VP complement, forcing *te* to climb up, and so the structures (54) is used for the *quiere* clause. The *permitir* clause takes a structure like (55a), but with the difference that its complement is TP, not VP. Therefore the clause for *ver* is (51b), and *lo* stays in the *ver* clause.

²⁴Space prevents further discussion here, but Bleam (1994) used the locality properties of the TAG variant called 'set-local TAG' to derive the unacceptability of the violations of (d) and (e). The fact that the system described here accomplishes the same result suggests that the crucial issue has not the particular features of set-local TAG, but rather the typology of the trees, as long as the derivational machinery can take advantage of their properties.

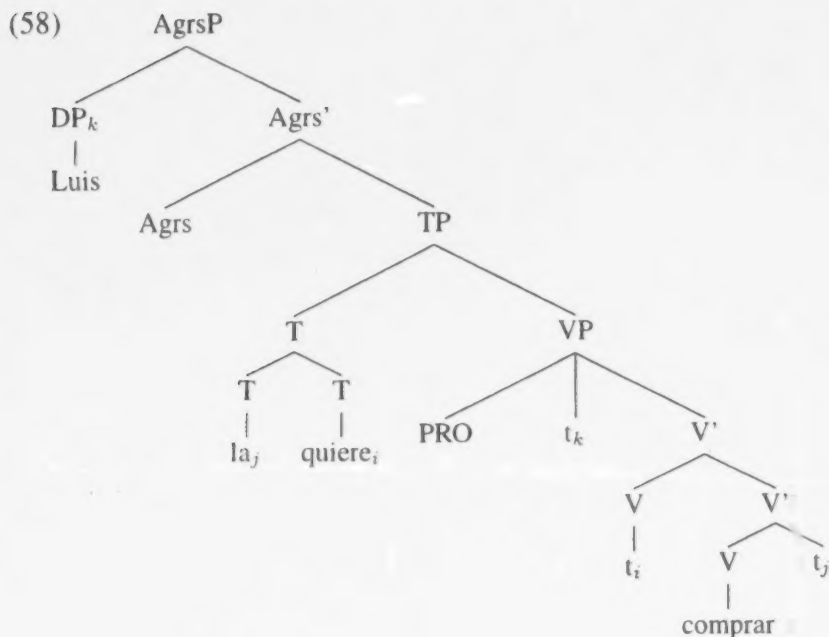


- (56) Luis *la quiere comprar*
 Luis it wants to buy
 'Luis wants to buy it'

We end with a brief comment on the problem of licensing PRO in the VP complement. The use of 'identifying' the floating elements allows for what may be an interesting approach to this problem. Suppose that in a sentence such as (56), *quiere* takes a V', not a VP, complement, shown in (57a), although the complement clause (57b) is still a VP clause. The difference now is that the V', not the VP, node of (57b) substitutes into (57a) at its bottom V' node. Now all the material that c-commands V' in (57b), namely the PRO specifier of VP and the clitic, and the material that c-commands the higher V' node in (57a) are subject to the DCETM. This has the effect of making both PRO from the *comprar* clause and the t_k trace of the subject from the *quiere* clause both be specifiers of the same VP, resulting in (58).

This is the same situation as in the superraising case (34), except that there it was multiple IP specifiers, rather than multiple VP specifiers here, where one specifier is a PRO. It is easy to imagine a story whereby PRO can be licensed in this configuration, by getting coindexed with the other specifier of VP. We leave for future work the exact working out of this account. It is encouraging to note, though, that this possibility follows from the derivational machinery used so far.²⁵

²⁵There is some similarity between this 'multiple [Spec, VP]' approach to defective complements and the 'movement-to-[Spec, VP]' approach of Boskovic (1994). We leave for future work a comparison of these approaches.



8 Conclusion

In this paper we have discussed an analysis of clitic climbing with the framework of Tree Adjoining Grammar. We showed that the analysis proposed by Bleam (1994) is inadequate for certain cases, in particular those in which the trigger verb is a raising or bridge verb. We discussed how by adopting the reconceptualization of TAG as monotonic c-command as proposed elsewhere, these problems can be overcome. This leads naturally to a conception of inter-clausal movement in TAG in which an internal node of the lower clause substitutes into a node of the higher clause with the higher parts of each clause 'merging' together, in the sense discussed. The derivational structure is the same for all types of inter-clausal movement—as discussed in this paper, for *wh*-movement, raising, and clitic-climbing. The differences in their properties arise from the differing loci of substitution, and the consequences of that location for movement in the structure for the lower clause (how far an NP has to move to be above the locus of substitution).

There are a number of issues related to this work that require further investigation. The most immediate is a precise characterization of the 'floating' elements and how they are 'identified' by the DCETM. The view suggested here based on the recursive structure of the higher clause may be useful, or

it may be possible to characterize the floating components solely in terms of how 'loose' they are in the c-command relations.

There are several details regarding the analysis of clitic-climbing that need to be cleaned up. One is the issue of the clitic-verb order. A second issue, perhaps more serious and certainly more interesting, concerns how the clausal structures differ in the clitic and non-clitic-climbing cases. Ideally, we would like for there to be just a 'one bit' difference between the two cases—one parameter is changed, and clitic climbing either occurs or not. In particular, we would like to say that if the higher clause takes a different size complement (VP or TP), then clitic-climbing either does or does not occur. However, in the analysis described here, the complement size taken by the higher clause must correlate with the structure of the lower clause. That is because, given the assumption that the verb moves to T, the infinitival lower verb moves to T when there is no clitic climbing, and does not move to T when there is. If the higher clause selects a VP complement, then the lower clause must not have a TP projection, and the clitic must be 'floating' by itself. If the lower clause did have a TP projection, then the verb would move to that T projection, and then both the clitic and the lower verb would end up above the higher verb, obviously undesirable. The most obvious way to fix this problem is to modify the placement of the clitic to be above the place where the infinitival verb moves. Then the desired result could obtain in which the lower infinitival clause is always the same, with the appearance of the clitic in the lower or higher clause dependent only on the size of the complement selected by the higher verb.

One further area of work is the investigation of how other problematic cases of long-distance movement, such as long distance scrambling in German (Rambow (1994)), should be integrated into this approach. Of particular interest is whether such scrambling follows the pattern of 'intersecting clitic climbing' as in (49) and if not, how the different patterns of movement can be integrated into this approach without altering the basic derivational mechanism.

Also, the other aspects of 'restructuring' in Romance, such as the 'long middle-*si*', should be integrated into this approach. For reasons that can't be discussed here, these other aspects raise different challenges for TAG (see Kulick (1998) for discussion). There is also an interaction between these other aspects and clitic climbing that is important to capture.

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The Convergence of Lexicalist Perspectives in Psycholinguistics and Computational Linguistics*

Albert E. Kim, Bangalore Srinivas and John C. Trueswell

1 Introduction

In the last fifteen years, there has been a striking convergence of perspectives in the fields of linguistics, computational linguistics, and psycholinguistics regarding the representation and processing of grammatical information. First, the lexicon has played an increasingly important role in the representation of the syntactic aspects of language. This is exemplified by the rise of grammatical formalisms that assign a central role to the lexicon for characterizing syntactic forms, e.g., LFG (Bresnan and Kaplan 1982), HPSG (Pollard and Sag 1994), CCG (Steedman 1996), Lexicon-Grammars (Gross 1984), LTAG (Joshi and Schabes 1996), Link Grammars (Sleator and Temperley 1991) and the Minimalist Program (Chomsky 1995). Second, theories of language processing have seen a shift away from 'rule-governed' approaches for grammatical decision-making toward statistical and constraint-based approaches. In psycholinguistics, this has been characterized by a strong interest in connectionist and activation-based models (e.g., Lewis 1993, McRae, Spivey-Knowlton and Tanenhaus 1998, Stevenson 1994, Tabor, Juliano and Tanenhaus 1996). In computational linguistics, this is found in the explosion of work with stochastic approaches to structural processing (cf. Church and Mercer 1993, Marcus 1995). In linguistics, this interest is most apparent in the development of Optimality Theory (Prince and Smolensky 1997).

In this paper, we highlight how the shift to lexical and statistical approaches has affected theories of sentence parsing in both psycholinguistics and computational linguistics. In particular, we present an integration of ideas developed across these two disciplines, which builds upon a specific proposal from each. Within psycholinguistics, we discuss the development of the Constraint-Based Lexicalist (CBL) theory of sentence processing (MacDonald, Pearlmuter and Seidenberg 1994, Trueswell and Tanenhaus 1994).

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Within computational linguistics, we discuss the development of statistical approaches to processing Lexicalized Tree-Adjoining Grammar (LTAG, Joshi and Schabes 1996). Finally, we provide a description of the CBL theory, which is based on LTAG.

2 A Constraint-Based Theory of Sentence Processing

Psycholinguistic thinking about the syntactic aspects of language comprehension has been deeply influenced by theories that assign a privileged role to supra-lexical syntactic representations and processes. This view has been most extensively developed in the theory of Frazier (1979, 1989), which proposed that syntactic processing is controlled by a two-staged system. In the first stage, a single syntactic representation of the input is computed using a limited set of phrase structure rules and basic grammatical category information about words. When syntactic knowledge ambiguously allows multiple analyses of the input, a single analysis is selected using a small set of structure-based processing strategies. In a second stage of processing, the output of this structure-building stage is integrated with and checked against lexically specific knowledge and contextual information, and initial analyses are revised if necessary. The basic proposal of this theory—that syntactic processing is, at least in the earliest stages, independent from lexically specific and contextual influences—has been one of the dominant ideas of sentence processing theory (e.g., Ferreira and Clifton 1986, Perfetti 1990, Mitchell 1987, 1989, Rayner, Carlson and Frazier 1983).

A diverse group of recent theories has challenged this two-stage structure-building paradigm by implicating some combination of lexical and contextual constraints and probabilistic processing mechanisms in the earliest stages of syntactic processing (Crocker 1994, Corley and Crocker 1996, Ford, Bresnan and Kaplan 1982, Gibson 1998, Jurafsky 1996, MacDonald et al. 1994, Pritchett 1992, Stevenson 1994, Trueswell and Tanenhaus 1994). We focus in this paper on the body of work known as the Constraint-Based Lexicalist theory (MacDonald et al. 1994, Trueswell and Tanenhaus 1994), which proposes that all aspects of language comprehension, including the syntactic aspects, are better described as the result of pattern recognition processes than the application of structure building rules. Word recognition is proposed to include the activation of rich grammatical structures (e.g., verb argument structures), which play a critical role in supporting the semantic interpretation of the sentence. These structures are activated in a pattern shaped by frequency, with grammatically ambiguous words causing the temporary activation of multiple structures. The selection of the appropriate structure for each word, given the context, accomplishes much of the work

of syntactic analysis. That is, much of the syntactic ambiguity in language is proposed to stem directly from lexical ambiguity and to be resolved during word recognition.¹ The theory predicts that initial parsing preferences are guided by these grammatical aspects of word recognition.

The CBL framework can be illustrated by considering the role of verb argument structure in the processing of syntactic ambiguities like the Noun Phrase / Sentence Complement (NP/S) ambiguity in sentences like (1a) and (1b).

- (1) a. *The chef forgot the recipe was in the back of the book.*
 b. *The chef claimed the recipe was in the back of the book.*

In (1a), a temporary ambiguity arises in the relationship between the noun phrase *the recipe* and the verb *forgot*. Due to the argument structure possibilities for *forgot*, the noun phrase could be the direct object or the subject of a sentence complement. In sentences like this, readers show an initial preference for the direct object interpretation of the ambiguous noun phrase, resulting in increased reading times at the disambiguating region *was in...* (e.g., Holmes, Stowe and Cupples 1989, Ferreira and Henderson 1990, Rayner and Frazier 1987). On the CBL theory, the direct object preference in (1a) is due to the lexical representation of the verb *forgot*, which has a strong tendency to take a direct object rather than a sentence complement. The CBL theory proposes that word recognition includes the activation of not only semantic and phonological representations of a word, but also detailed syntactic representations. These lexico-syntactic representations, and the processes by which they are activated, are proposed to play critical roles in the combinatorial commitments of language comprehension. The preference for the direct object in (1a) should therefore be eliminated when the verb *forgot* is replaced with a verb like *claimed*, which has a strong tendency to take a sentence complement rather than a direct object. These predictions have been confirmed experimentally (Trueswell, Tanenhaus and Kello 1993, Garnsey, Pearlmutter, Myers and Lockety 1997), and connectionist models have been constructed which capture these preferences (Juliano and Tanenhaus 1994, Tabor et al. 1996).

Experimental work has also indicated that the pattern of processing

¹The amount of syntactic structure that is lexically generated goes beyond the classical notion of argument structure. In lexicalized grammar formalisms such as LTAG, the entire grammar is in the lexicon. For instance, the attachment site of a preposition can be treated as a lexically specific feature. Noun-attaching prepositions and verb-attaching prepositions have different senses. We will discuss this in further detail in the following sections.

commitments is not determined solely by individual lexical preferences, but involves an interaction between argument structure preference and lexical frequency. NP-biased verbs result in strong direct object commitments regardless of the lexical frequency of the verb. S-bias verbs, on the other hand, show an effect of frequency, with high frequency items resulting in strong S-complement commitments and low frequency items resulting in much weaker S-complement commitments (Juliano and Tanenhaus 1993, though see Garnsey et al. 1997). This interaction between frequency and structural preference is explained by Juliano and Tanenhaus (1993) as occurring because the argument structure preferences of S-bias verbs must compete for activation with the regular pattern of the language—that an NP after a verb is a direct object. The ability of the S-bias verbs to overcome this competing cue depends upon frequency. Juliano and Tanenhaus (1994) present a connectionist model that shows that such interactions emerge naturally from constraint-based lexicalist models, since the models learn to represent more accurately the preferences of high frequency items. In later sections, we return to the issue of interactions between lexical frequency and ‘regularity’ and discuss its implications for the architecture of computational models of language processing.

The CBL theory has provided an account for experimental results involving a wide range of syntactic ambiguities (e.g., Boland, Tanenhaus, Garnsey and Carlson 1995, Garnsey et al. 1997, Juliano and Tanenhaus 1993, Trueswell and Kim 1998, MacDonald 1993, 1994, Spivey-Knowlton and Sedivy 1995, Trueswell et al. 1993, Trueswell, Tanenhaus and Garnsey 1994, cf. MacDonald et al. 1994). As this body of experimental results has grown, there has been a need to expand the grammatical coverage of computational modeling work to match that of the most comprehensive descriptions of the CBL theory, which have been wide in scope, but have not been computationally explicit (MacDonald et al. 1994, Trueswell and Tanenhaus 1994). Existing computational models have focused on providing detailed constraint-based accounts of the pattern of processing preferences for particular sets of experimental results (McRae et al. 1998, Tabor et al. 1996, Spivey-Knowlton 1996, Juliano and Tanenhaus 1994). These models have tended to be limited syntactic processors, with each model addressing the data surrounding a small range of syntactic ambiguities (e.g., the NP/S ambiguity). This targeted approach has left open some questions about how CBL-based models ‘scale up’ to more complicated grammatical tasks and more comprehensive samples of the language. For instance, the Juliano and Tanenhaus model learns to assign seven different verb complement types based on co-occurrence information about a set of less than 200 words. The full language involves a much greater number of syntactic possibilities and

more complicated co-occurrence relationships. It is possible that the complexities of computing the fine-grained statistical relationships of the full language may be qualitatively greater than in these simple domains, or even intractable (Mitchell, Cuetos, Corley and Brysbaert 1995). It is also possible that these targeted models are so tightly focused on specific sets of experimental data that they have acquired parameter settings that are inconsistent with other data (see Frasier 1995). Thus, there is a need to examine whether the principles of the theory support a model that provides comprehensive syntactic coverage of the language but which still predicts fine-grained patterns of argument structure availability.

3 *Lexicalized Grammars and Superlagging*

In developing a broader and more formal account of psycholinguistic findings, we have capitalized on a convergence between the CBL movement in psycholinguistics and similar movements in theoretical and computational linguistics. Theoretical linguistics has increasingly treated the lexicon, rather than supra-lexical rules, as the repository of syntactic information, giving rise to "lexicalist" grammars (Bresnan and Kaplan 1982, Pollard and Sag 1994, Joshi and Schabes 1996, Steedman 1996). In a parallel development, computational linguistics has produced an extensive body of work on statistical techniques for ambiguity resolution such as part-of-speech tagging and stochastic parsing methods. Within this work, methods that have focused on the statistics of lexical items have generally outperformed methods that focus on the statistics of supra-lexical structural events, such as statistical context free grammars (Marcus 1995). The success of these approaches to processing has expanded the set of computational mechanisms made available to psycholinguistics as conceptual tools. Both of these developments have been similar in spirit to CBL thinking. We have attempted to advance the formal specification of constraint-based proposals in psycholinguistics by building upon the foundation of one lexicalist grammatical formalism, Lexicalized Tree-Adjoining Grammar (LTAG, Joshi and Schabes 1996). We have also drawn insights from work on statistical techniques for processing over LTAG (Krnlivas and Joshi 1998). This section introduces LTAG and representational and processing issues within it.

The idea behind LTAG is to localize the computation of linguistic structure by associating lexical items with rich descriptions that impose complex combinatorial constraints in a local context. Each lexical item is associated with at least one "elementary tree" structure, which encodes the "minimal syntactic environment" of a lexical item. This includes such information as head-complement requirements, filler-gap information, tense,

and voice. Figure 1 shows some of the elementary trees associated with the words of the sentence *The police officer believed the victim was lying*.² The trees involved in the correct parse of the sentence are highlighted by boxes. Note that the highlighted tree for *believed* specifies each of the word's arguments, a sentential complement and a noun phrase subject.

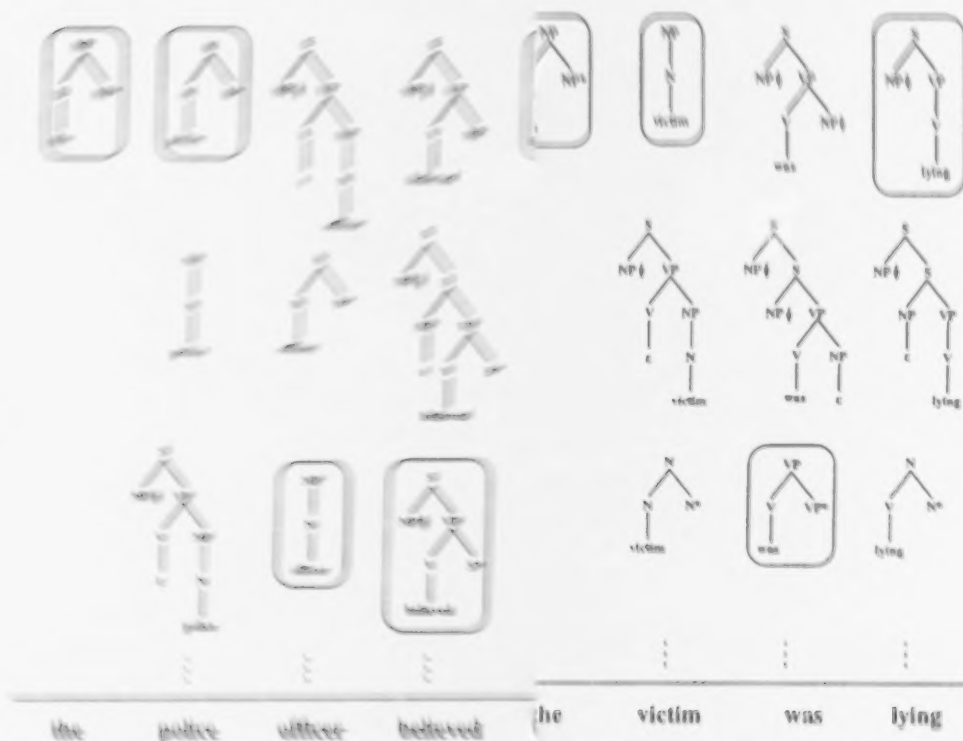


Figure 1: A partial illustration of the elementary tree possibilities for the sentence *the police officer believed the victim was lying*. Trees involved in the correct parse of the sentence are highlighted in boxes.

Encoding combinatory information in the lexicon rather than in supranatural rules has interesting effects on the nature of structural analysis. One effect is that the number of different descriptions for each lexical item becomes much larger than when the descriptions are less complex. For in-

²The down-arrows and asterisks in the trees mark nodes at which trees make contact with each other during the two kinds of combinatory operations of Tree Adjoining Grammar, substitution and adjunction. Down-arrows mark nodes at which the substitution operation occurs, and asterisks mark footnodes, which participate in the adjunction operation. The details of the combinatory operations of TAG are beyond the scope of this paper. See Joshi and Schabes (1996) for a discussion.

stance, the average elementary tree ambiguity for a word in Wall Street Journal text is about 47 trees (Srinivas and Joshi 1998). In contrast, part-of-speech tags, which provide a much less complex description of words, have an ambiguity of about 1.2 tags per word in Wall Street Journal text. Thus, lexicalization increases the local ambiguity for the parser, complicating the problem of lexical ambiguity resolution. The increased lexical ambiguity is partially illustrated in Figure 1, where six out of eight words have multiple elementary tree possibilities. The flip-side to this increased lexical ambiguity, however, is that resolution of lexical ambiguity yields a representation that is effectively a parse, drastically reducing the amount of work to be done after lexical ambiguity is resolved (Srinivas and Joshi 1998). This is because the elementary trees impose such complex combinatory constraints in their own local contexts that there are very few ways for the trees to combine once they have been correctly chosen. The elementary trees can be understood as having 'compiled out' what would be rule applications in a context-free grammar system, so that once they have been correctly assigned, most syntactic ambiguity has been resolved. Thus, the lexicalization of grammar causes much of the computational work of structural analysis to shift from grammatical rule application to lexical ambiguity resolution. We refer to the elementary trees of the grammar as *supertags*, treating them as complex analogs to part-of-speech tags. We refer to the process of resolving supertag ambiguity as *supertagging*. One indication that the work of structural analysis has indeed been shifted into lexical ambiguity resolution is that the run-time of the parser is reduced by a factor of thirty when the correct supertags for a sentence are selected in advance of parsing.³

Importantly for the current work, this change in the nature of parsing has been complemented by the recent development of statistical techniques for lexical ambiguity resolution. Simple statistical methods for resolving part-of-speech ambiguity have been one of the major successes in recent work on statistical natural language processing (cf. Church and Mercer 1993, Marcus 1995). Several algorithms tag part-of-speech with accuracy between 95% and 97% (cf. Charniak 1993). Applying such techniques to the words in a sentence before parsing can substantially reduce the work of the parser by preventing the construction of spurious syntactic analyses. Recently, Srinivas and Joshi (1998) have demonstrated that the same techniques can be effective in resolving the greater ambiguity of supertags. They implemented a tri-

³This is based on run-times for a sample of 1300 sentences of Wall Street Journal text, reported by Srinivas and Joshi (1998). Running the parser without supertagging took 120 seconds, while running it with correct supertags pre-assigned took 4 seconds.

gram Hidden Markov Model of supertag disambiguation. When trained on 200,000 words of parsed Wall Street Journal text, this model produced the correct supertag for 90.9% of lexical items in a set of held out testing data.

Thus, simple statistical techniques for lexical ambiguity resolution can be applied to supertags just as they can to part-of-speech ambiguity. Due to the highly constraining nature of supertags, these techniques have an even greater impact on structural analysis when applied to supertags than when applied to part-of-speech tagging. These results provide a demonstration that much of the computational work of linguistic analysis, which has traditionally been understood as the result of structure building operations, might instead be seen as lexical disambiguation. This has important implications for how psycholinguists are to conceptualize structural analysis. It expands the potential role in syntactic analysis of simple pattern recognition mechanisms for word recognition, which have played a very limited role in classical models of human syntactic processing.

Note that the claim here is not that supertagging accomplishes the entire task of structural analysis. After elementary trees have been selected for the words in a sentence, there remains the job of connecting the trees via the LTAG combinatory operations of adjunction and substitution. The principal claim of this section is that in designing a system for syntactic analysis there are sound linguistic and engineering reasons for storing large amounts of grammatical information in the lexicon and for performing much of the work of syntactic analysis with something like supertagging. If such a system is also to be used as a psycholinguistic model, it is natural to predict that many of the initial processing commitments of syntactic analysis are made by a level of processing analogous to supertagging. In the following section, we discuss how an LTAG-based supertagging system resolves at the lexical level many of the same syntactic ambiguities that have concerned researchers in human sentence processing, suggesting that a supertagging system might provide a good psycholinguistic model of syntactic processing. Thus, although the question of how such a system fits into a complete language processing system is an important one, it may be useful to begin exploring the psychological implications of supertagging in advance of a thorough understanding of how to design the rest of the system.⁴

⁴Srinivas (1997) has suggested that this can be done by a process that is simpler than full parsing. He calls this process "stapling".

4 A Model of the Grammatical Aspects of Word Recognition Using LTAG

In the remaining sections of this paper, we describe an on-going project which attempts to use LTAG to develop a more fully-specified account of the CBL theory of human sentence processing. We argue that the notion of supertagging can become the basis of a model of the grammatical aspects of word recognition, provided that certain key adjustments are made to bring it in line with the assumptions of psycholinguistic theory (Kim et al., in preparation). Before introducing this model, we outline how LTAG can be used to advance the formal specification of the CBL theory.⁵ We then turn to some of the findings of the model, which capture some of the major phenomena reported in the human parsing literature.

LTAG lexicalizes syntactic information in a way that is highly consistent with descriptions of the CBL theory, including the lexicalization of head-complement relations, filler-gap information, tense, and voice. The value of LTAG as a formal framework for a CBL account can be illustrated by the LTAG treatment of several psycholinguistically interesting syntactic ambiguities, e.g., prepositional phrase attachment ambiguity, the NP/S complement ambiguity, the reduced relative/main clause ambiguity, and the compound noun ambiguity. In all but one of these cases, the syntactic ambiguity is characterized as stemming from a lexical ambiguity.

Figure 2 (below) presents the LTAG treatment of these ambiguities. Each of the sentence fragments in the figure ends with a syntactically ambiguous word and is accompanied by possible supertags for that word. First, the prepositional phrase attachment ambiguity is illustrated in Figure 2a. The ambiguity lies in the ability of the prepositional phrase *with the ...* to modify either the noun phrase *the cop* (e.g., *with the red hair*) or modify the verb phrase headed by *saw* (e.g., *with the binoculars*). Within LTAG, prepositions like *with* indicate lexically whether they modify a preceding noun phrase or verb phrase. This causes prepositional phrase attachment ambiguities to hinge on the lexical ambiguity of the preposition. Similarly, the NP/S ambiguity discussed in the Introduction arises directly from the ambiguity between the elementary trees shown in Figure 2b. In this case, these trees encode the different complement-taking properties of the verb *forgot* (e.g., *the recipe* vs. *the recipe was ...*) Figure 2c shows a string that could be parsed as a Noun-Noun compound (e.g., *the warehouse fires were extinguished*) or a

⁵Of course, formal specification of this theory can be achieved by using other lexicalized grammatical frameworks, e.g., LFG (Bresnan and Kaplan 1982), HPSG (Pollard and Sag 1994), CCG (Steedman 1996).

Subject-Verb sequence (e.g., *the warehouse fires older employees.*). In non-lexicalist grammars, this ambiguity is treated as arising from the major category ambiguity of *fires*. In LTAG, this ambiguity involves not only the category ambiguity but also a more fine-grained ambiguity regarding the previous noun *warehouse*. Due to the nature of combinatory operations of LTAG, nouns that appear as phrasal heads or phrasal modifiers are assigned different types of elementary trees (i.e., the *Alpha-/Beta-* distinction in LTAG, see Doran, Egedy, Hockey, Srinivas and Zaidel 1994). Figure 2d illustrates the reduced relative/main clause ambiguity (e.g., *the defendant examined by the lawyer was ...* vs. *the defendant examined the pistol.*). Here again, the critical features of the phrase structure ambiguity are lexicalized. For instance, the position of the gap in an object-extraction relative clause is encoded at the verb (right-hand tree in Figure 2d). This is because LTAG trees encode the number, type, and position of all verb complements, including those that have been extracted. Finally, Figure 2e illustrates a structural ambiguity that is not treated lexically in LTAG. As in Figure 2a, the preposition *with* is associated with two elementary trees, specifying verb phrase or noun phrase modification. However, in this example, both attachment possibilities involve the same tree (NP-attachment), which can modify either *general* or *secretary*. The syntactic information that distinguishes between local and non-local attachment is not specified lexically. So, within LTAG, this final example is a case of what we might call true attachment ambiguity. This example illustrates the point made earlier that even when a lexical tree is selected, syntactic processing is not complete, since lexical trees need to be combined together through the operations of substitution and adjunction. In the first four examples, the selection of lexical trees leaves only a single way to combine these items. In the final example, however, multiple combinatory possibilities remain even after lexical selection.

The examples in Figure 2 illustrate the compatibility of LTAG with the CBL theory. Both frameworks lexicalize structural ambiguities in similar ways, with LTAG providing considerably more linguistic detail. This suggests that LTAG can be used to provide a more formal statement of the representational claims of the CBL theory. For instance, one can characterize the grammatical aspects of word recognition as the parallel activation of possible elementary trees. The extent to which a lexical item activates a particular elementary tree is determined by the frequency with which it has required that tree during an individual's linguistic experience. The selection of a single tree is accomplished through the satisfaction of multiple probabilistic constraints, including semantic and syntactic contextual cues. The CBL theory has traditionally focused on the activation of verb argument structure. The introduction of a wide-coverage grammar into this theory generates

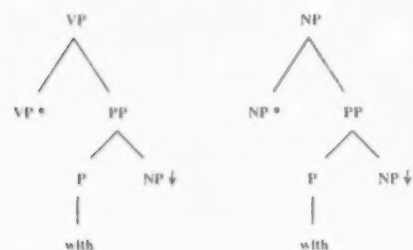
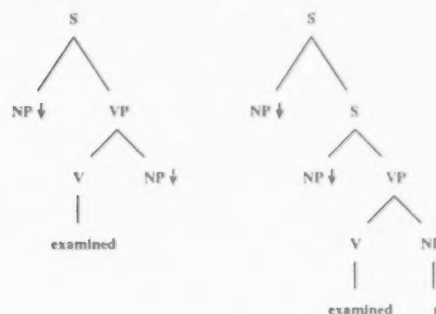
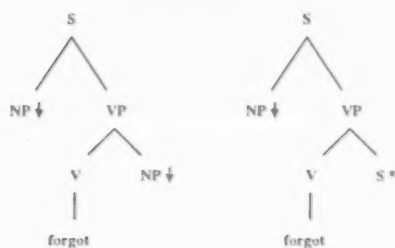
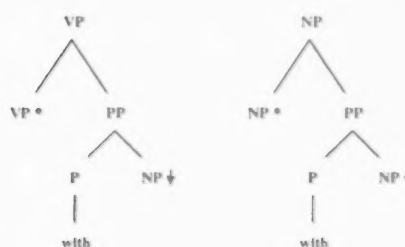
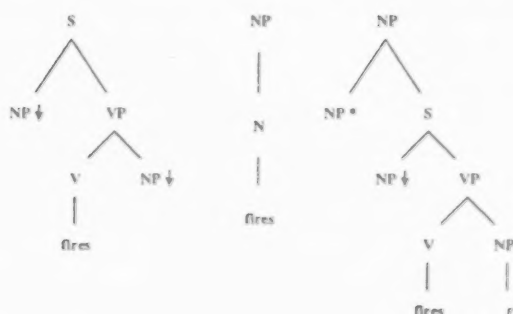
(a) The spy saw the cop *with* ...(d) The defendent *examined*...(b) The student *forgot*...(e) The secretary of the general *with* ...(c) The warehouse *fires* ...

Figure 2: LTAG treatment of several psycholinguistically interesting syntactic ambiguities: (a) PP-attachment ambiguity; (b) NP/S ambiguity; (c) N/V category ambiguity; (d) reduced relative/main clause ambiguity; (e) PP-attachment ambiguity with both attachment sites being nominal.

clear predictions about the grammatical representations of other words. In particular, the same ambiguity resolution processes occur for all lexical items for which LTAG specifies more than one elementary tree.

The grammatical predictions of LTAG are worked out in an English grammar, which is the product of an ongoing grammar development project at the University of Pennsylvania (Doran et al. 1994). The grammar provides lexical descriptions for 37,000 words and handles a wide range of syntactic phenomena, making it a highly robust system. The supertagging work described in this paper makes critical use of this grammar. The comprehensiveness of the grammar makes it a valuable tool for psycholinguistic work, by allowing formal statements about the structural properties of a large fragment of the language. In our case, it plays a critical role in our attempt to 'scale up' CBL models in order to investigate the viability of such models on closer approximations to the full language than they have been tested on before.

4.1 Implementation

In this section, we describe preliminary results of a computational modeling project exploring the ability of the CBL theory to integrate the representations of LTAG. We have been developing a connectionist model of the grammatical aspects of word recognition, which attempts to account for various psycholinguistic findings pertaining to syntactic ambiguity resolution (Kim et al., in prep.). Unlike previous connectionist models within the CBL approach (McRae et al. 1998, Tabor et al. 1997, Spivey-Knowlton 1996, Juliano and Tanenhaus 1994), this model has wide coverage in that it has an input vocabulary of 20,000 words and is designed to assign 304 different LTAG elementary trees to input words. The design of the model was not guided by the need to match a specific set of psycholinguistic data. Rather, we applied simple learning principles to the acquisition of a wide coverage grammar, using as input a corpus of highly-variable, naturally occurring text. Certain patterns of structural preferences and frequency effects, which are characteristic of human data, fall directly out of the model's system of distributed representation and frequency-based learning.

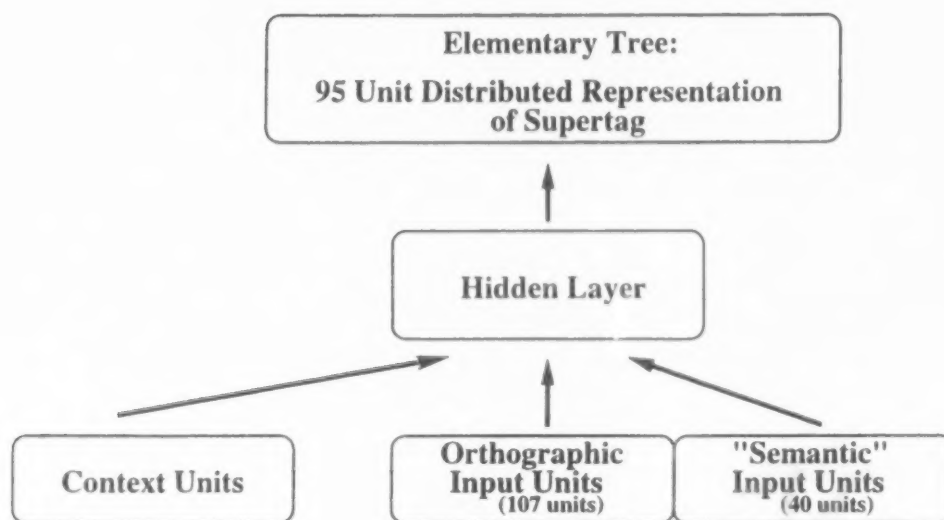
The model resembles the statistical supertagging model of Srinivas and Joshi 1998, which we briefly described above. We have, however, made key changes to bring it more in line with the assumptions behind the CBL framework. The critical assumptions are that human language comprehension is characterized by distributed, similarity-based representations (cf. Seidenberg 1992) and by incremental processing of a sentence. The Srinivas and Joshi model permits the use of information from both left and right con-

text in the syntactic analysis of a lexical item (through the use of Viterbi decoding). Furthermore, their model has a 'perfect' memory, which stores the structural events involving each lexical item separately and without error. In contrast, our model processes a sentence incrementally, and its input and internal representations are encoded in a distributed fashion. Distributed representations cause each representational unit to play a role in the representation of many lexical items, and the degree of similarity among lexical items to be reflected in the overlap of their representations.

These ideas were implemented in a connectionist network, which provided a natural framework for implementing a distributed processing system.⁶ The model takes as input information about the orthographic and semantic properties of a word and attempts to assign the appropriate supertag for the word given the local left context. The architecture of the model consists of three layers with feed-forward projections, as illustrated in Figure 3 on the next page.

The model's output layer is a 95 unit array of syntactic features which is capable of uniquely specifying the properties of 304 different supertags. These features completely specify the components of an LTAG elementary tree: 1) part-of-speech, 2) type of 'extraction', 3) number of complements, 4) category of complement, and 5) position of complements. Each of these components is encoded with a bank of localist units. For instance, there is a separate unit for each of 14 possible parts of speech, and the correct activation pattern for a given supertag activates only one of these units (e.g., "Noun"). The model was given as input rudimentary orthographic information and fine-grained distributional information about a word. 107 of the units encoded orthographic features, such as the 50 most common three-letter word-initial segments (e.g., *ins*), the 50 most common two-letter word-final segments (e.g., *ed*), and seven properties such as capitalization, hyphenation, etc. The remaining 40 input units provide a 'distributional profile' of each word, which was derived from a co-occurrence analysis.

⁶This is not to say that left-to-right processing and overlapping representations cannot be incorporated into a symbolic statistical system. However, most attempts within psycholinguistics to incorporate these assumptions into a computationally explicit model have been made within the connectionist framework (e.g., Elman 1990, Juliano and Tanenhaus 1994, Seidenberg and McClelland 1989). By using a connectionist architecture for the current model, we are following this precedent and planning comparisons with existing modeling results.



OH model: Context Units = Output pattern from previous word

2W model: Context Units = Input pattern from previous word

Figure 3: Architecture of the model

The orthographic encoding scheme served as a surrogate for the output of morphological processing, which is not explicitly modeled here but is assumed to be providing interactive input to lexico-syntactic processes that are modeled. The scheme was chosen primarily for its simplicity—it was automatically derived and easily applied to the training and testing corpus, without requiring the use of a morphological analyzer. It was expected to correlate with the presence of common English morphological features.

Similarly, the distributional profiles were used as a surrogate for the activation of detailed semantic information during word recognition. Although space prevents a detailed discussion, we note that several researchers have found that co-occurrence-based distributional profiles provide detailed information about the semantic similarity between words (cf. Burgess and Lund 1997, Landauer and Dumais 1997, Schütze 1993). The forty-dimensional profiles used here were created by first collecting co-occurrence statistics for a set of 20,000 words in a large corpus of newspaper text.⁷ The co-occurrence matrix was compressed by extracting the 40 principal compo-

⁷For each of the 20,000 target words, we counted co-occurrences with a set of 600 high frequency "context" words in 14 million words of Associated Press news-wire. Co-occurrences were collected in a six-word window around each target word (three words to either side of the word).

nents of a Singular Value Decomposition (see Kim et al., in preparation, for details). An informal inspection of the space reveals that it captures certain grammatical and semantic information. Table 1 shows the nearest neighbors in the space for some selected words. These are some of the better examples, but in general the information in the space consistently encodes semantic similarities between words.

Word	Nearest Neighbors by Distributional Profile
scientist	researcher, scholar, psychologist, chemist
london	tokyo, chicago, atlanta, paris
literature	poetry, architecture, drama, ballet
believed	feared, suspected, convinced, admitted
bought	purchased, loaned, borrowed, deposited
smashed	punched, cracked, flipped, slammed
confident	hopeful, optimistic, doubtful, skeptical
certainly	definitely, obviously, hardly, usually
From	with, by, at, on

Table 1: Nearest neighbors of sample words based on distributional profiles.

We implemented two architectural variations on the basic architecture described above, which gave the model an ability to maintain information over time so that its decisions would be context sensitive. The first variation expanded the input pattern to provide on each trial a copy of the input pattern from the previous time step along with the current input. This allowed the network's decisions about the current input to be guided by information about the preceding input. We will call this architecture the *two-word input* model (2W). The second variation provided simple recurrent feedback from the output layer to the hidden layer so that on a given trial the hidden layer would receive the previous state of the output layer. This again allowed the model's decision on a given trial to be contingent on activity during the previous trial. We call this architecture the *output-to-hidden* architecture (OH). For purposes of brevity, we discuss only the results of the 2W architecture. In all statistical analyses reported here, the OH architecture produced the same effects as the 2W architecture.

The model was trained on a 195,000 word corpus of Wall Street Journal text, which had been annotated with supertags. The annotation was done by translating the annotations of a segment of the Penn Treebank (Marcus, Santorini and Marcinkiewicz 1993) into LTAG equivalents (Srinivas 1997). During training, for each word in the training corpus, the appropriate ortho-

graphic units and distributional profile pattern were activated in the input layer. The input activation pattern was propagated forward through the hidden layer to the output layer. Learning was driven by back propagation of the error between the model's output pattern and the correct supertag pattern for the current word (Rumelhart, Hinton and Williams 1986).

We tested the overall performance of the model by examining its supertagging accuracy on a 12,000 word subset of the training corpus that was held out of training. The network's syntactic analysis on a given word was considered to be the supertag whose desired activation pattern produced the lowest error with respect to the model's actual output (using least squares error). On this metric, the model guessed correctly on 72% of these items. Using a slightly relaxed metric, the correct supertag was among the model's top three choices (the three supertags with the lowest error) 80% of the time. This relaxed metric was used primarily to assess the model's potential for increased overall accuracy in future work, if the correct analysis was highly activated even when it was not the most highly activated analysis, then future changes might be expected to increase the model's overall accuracy (e.g., improvements to the quality of the input representation). Accuracy for basic part of speech on the relaxed metric was 91%. The performance of the network can be compared to 79% accuracy for a 'greedy' version of the trigram model of Srinivas and Joshi (1998), which was trained on the same corpus. The greedy version eliminated the previously mentioned ability of the original model to be influenced by information from right context in its decisions about a given word.

Although these results indicate that the model acquired a substantial amount of grammatical knowledge, the main goal of this work is to examine the relationship between the model's operation and human behavioral patterns, including the patterns of misanalysis characteristic of human processing. In pursuing this goal, we measure the model's degree of commitment to a given syntactic analysis by the size of its error to that analysis relative to its error to other analyses. We make the linking hypothesis that reading time elevations due to misanalysis and revision in situations of local syntactic ambiguity should be predicted by the model's degree of commitment to the erroneous syntactic analysis at the point of ambiguity. For example, in the NP/S ambiguity of example (1), the model's degree of commitment to the NP-complement analysis over the S-complement analysis should predict the amount of reading time elevation at the disambiguating region *was in...*

We conducted experiments on the model that mimic the structure of on-line processing experiments. The following section discusses the results of two experiments, which investigate the model's processing of the NP/S ambiguity and the noun/verb lexical category ambiguity.

4.2 Modeling the NP/S Ambiguity

One set of behavioral data that our model aims to account for is the pattern of processing difficulty around the NP/S ambiguity discussed in section 2 and exemplified in (1), repeated here as (2).

- (2) a. The chef forgot the recipe was in the back of the book.
b. The chef claimed the recipe was in the back of the book.

In (2a), comprehenders can initially treat the noun phrase *the recipe* as either the NP-complement of *forgot* or the subject of a sentential complement to *forgot*. Numerous experiments have found that readers of locally ambiguous sentences like (2a) often erroneously commit to a NP-complement interpretation (Holmes et al. 1989, Ferreira and Henderson 1990, Trueswell et al. 1993, Garnsey et al. 1997).

Several experiments have found that the general processing bias toward the NP-complement is modulated by the structural bias of the main verb (Trueswell et al. 1993, Garnsey et al. 1997). Erroneous commitments to the NP-complement interpretation are weakened or eliminated when the main verb has a strong S-bias (e.g., *claimed*). Recently, Trueswell and Kim (1998) have shown similar effects when verb bias information is introduced to processing through a lexical priming technique. Thus, the language processing system appears to be characterized simultaneously by an overall bias toward the NP-complement analysis and by the influence of the lexical preferences of S-bias verbs.

The coexistence of these two conflicting sources of guidance may be explained in terms of "neighborhoods of regularity" in the representation of verb argument structure (Seidenberg 1992, Juliano and Tanenhaus 1994). NP-complement and S-complement verbs occupy a neighborhood of representations, in which the NP-complement pattern dominates the "irregular" S-complement pattern, due to greater frequency. The ability of S-complement items to be represented accurately is dependent on frequency. High frequency S-complement items are accurately represented, but low frequency S-complement items are overwhelmed by their dominant NP-complement neighbors. Juliano and Tanenhaus (1993) found evidence in support of this hypothesis in a study in which the ability of verb bias information to guide processing was characterized by an interaction between the frequency and the subcategory of the main verb. The ability of S-complement verbs to guide processing commitments was correlated with the verb's lexical frequency. Low frequency S-complement verbs allowed erroneous commitments to the NP-complement analysis in spite of the verb's bias, while high

frequency S-complement items caused rapid commitments to the correct S-complement analysis.

We examined the model's processing of NP/S ambiguous sentence fragments like (3). Detailed results are reported by Kim et al. (in prep.).

(3) The economist decided ...

Twenty-eight verbs were selected on the basis of their frequency properties in the model's training corpus. Half of these strongly tended to take S-complements and half strongly tended to take NP-complements. Within each verb-bias type, half of the target verbs were high in frequency and half were low in frequency. Each NP-biased item was matched in frequency to a S-biased item. These verbs were then embedded in a sentence fragment, which was presented to the model. Table 2 shows examples of each of the four conditions that resulted from crossing verb bias with frequency.

Example	Frequency	Structural Bias
<i>The economist decided</i>	High	S-complement
<i>The economist elected</i>	High	NP-complement
<i>The economist denied</i>	Low	S-complement
<i>The economist achieved</i>	Low	NP-complement

Table 2: Examples of materials used to examine the model's NP/S subcategorization performance. Verb frequency and structural bias were determined from the properties of the training corpus.

The results of the experiment are summarized in Table 3. The model clearly recognizes NP/S verbs, as demonstrated by the consistency with which it assigned either a NP- or a S-complement supertag to the experimental items (27 of 28 items). Closer examination of the model's performance reveals major qualities of human comprehension data, including a general bias toward the NP-complement structure, which can be overcome by lexical information from high frequency S-complement verbs. As illustrated in Table 3, all 14 NP-biased verbs were correctly analyzed, but S-biased verbs were misanalyzed on 9 of 14 trials, with 8 of the 9 misanalyses being to the NP-complement. The dominance of the NP-complement analysis, however, is modulated by the frequency of exposure to S-complement items, matching the interaction between frequency and verb subcategory in human processing shown by Juliano and Tanenhaus (1994). The model showed high accuracy on S-biased verbs when they were high in frequency (5 out of 7 items were correctly analyzed) but showed a tendency to misanalyze low

frequency S-biased items as NP-complement items (all 7 were misanalyzed, with 6 of the errors being to the NP-complement).

Verb Sub-category	Frequency	S-comp	NP-comp	Other Supertags	Commitment to S-comp
S-comp	High	5	2	0	0.013
S-comp	Low	0	6	1	-1.0021
NP-comp	High	0	7	0	-1.1541
NP-comp	Low	0	7	0	-1.3343

Table 3: The model's structural analyses of NP/S Verbs.

We quantified the model's degree of commitment to the S-complement supertag over the NP-complement supertag by subtracting the model's error to the S-complement supertag from its error to the NP-complement supertag (*NP-complement error - S-complement error*).⁸ On this quantification, negative values indicate commitment to an NP-complement analysis while positive values indicate commitment to the S-complement analysis. This value was subjected to an Analysis of Variance with Frequency and Verb Bias as factors, which showed an interaction between Frequency and Verb Bias, $F(1,24) = 7.04$; $p < 0.05$, as well as main effects of Frequency, $F(1,24)=14.42$; $p < 0.001$ and Verb Bias, $F(1,24) = 22.69$, $p < 0.0001$.

Verb Subcategory Tokens	This Model	Juliano & Tanenhaus (1994)	Penn Treebank
S-complement	2708	1997	8502
NP-complement	10583	5686	31935
Other	17367 (11436 auxiliaries)	5368	89625
All	30658	13051	130062

Table 4: Frequency properties of various training corpora with respect to the NP/S ambiguity.

The model's frequency-by-subcategory interaction arises from its system of distributed representation and frequency sensitive learning. S-complement

⁸Both S-complement and NP-complement verbs come in multiple versions, corresponding to different constructions such as Wh-extraction, passivization, etc. In both cases, we computed error with respect to the unextracted, main clause tree.

verbs and NP-complement verbs have a substantial overlap in input representation, due to distributional and orthographic similarities (-ed, -ng, etc.) between the two types of verbs and the fact that S-complement verbs are often NP/S ambiguous. NP-complement tokens dominate S-complement tokens in frequency (4 to 1, as shown in Table 4), causing overlapping input features to be more frequently associated with the NP-complement output than the S-complement output during training. The result is that a portion of the input representation of S-complement verbs becomes strongly associated with the NP-complement output, causing a tendency for the model to misanalyze S-complement items as NP-complement items. The model is able to identify non-overlapping input features that distinguish S-complement verbs from their dominant neighbors, but its ability to do so is affected by frequency. When S-complement verbs are seen in high frequencies, their distinguishing features are able to influence connection weights enough to allow accurate representation; however, when S-complement verbs are seen in low frequencies, their NP-complement-like input features dominate their processing. The explanation here is similar to the explanation given by Seidenberg and McClelland (1989) for frequency-by-regularity interactions in word naming (e.g., the high frequency irregularity of *have* vs. the regularity of *gave*, *wave*, *save*) and past tense production.

The theoretical significance of this interaction lies partly in its emergence in a comprehensive model, which is designed to resolve a wide range of syntactic ambiguities over a diverse sample of the language. These results provide a verification of conclusions drawn by Juliano and Tanenhaus (1994) from a much simpler model, which acquired a similar pattern of knowledge about NP-complement and S-complement verbs from co-occurrence information about verbs and the words that follow them. It is important to provide such follow-up work for Juliano and Tanenhaus (1994), because their simplifications of the domain were extreme enough to allow uncertainty about the scalability of their results. Although their training materials were drawn from naturally occurring text (the Wall Street Journal and Brown corpora), they sampled only a subset of the verbs in that text and the words occurring after those verbs. S-complement tokens were more common in their corpus than in the full language (2.5 times more common than in the full corpus from which their training materials were drawn), and only past-tense tokens were sampled. This constitutes a substantial simplification of the co-occurrence information available in the full language. In our sample of the Wall Street Journal corpus, non-auxiliary verbs account for only 10.8% of all tokens, suggesting that the full language may contain many co-occurrence events that are 'noise' with respect to the pattern detected by the Juliano and Tanenhaus (1994) model. For instance, as they observe, their domain restricts

the range of contexts in which the determiner *the* occurs, obscuring the fact that in the full language, *the* often introduces a subject noun phrase rather than an object noun phrase. It is conceivable that the complexity of the full language would obscure the pattern of co-occurrences around the NP/S ambiguity sufficiently to prevent a scaled up constraint-based model from acquiring the pattern of knowledge acquired by the Juliano and Tanenhaus 1994 model. Our results demonstrate that the processing and representational assumptions that allow constraint based models to naturally express frequency-by-regularity interactions are scalable—they continue to emerge when the domain is made very complex.

4.3 Modeling the Noun/Verb Lexical Category Ambiguity

Another set of behavioral data that our model addresses is the pattern of reading times around lexical category ambiguities like that of *fires* in (4).

- (4) a. the warehouse *fires* burned for days.
b. the warehouse *fires* many workers every spring.

The string *warehouse fires* can be interpreted as a subject-verb sequence (4a) or a compound noun phrase (4b). This syntactic ambiguity is anchored by the lexical ambiguity of *fires*, which can occur as either a noun or a verb.

Several experiments have shown that readers of sentences like (4a) often commit erroneously to a subject-verb interpretation, as indicated by processing difficulty at the next word (*burned*), which is inconsistent with the erroneous interpretation and resolves the temporary ambiguity. Corley (1998) has shown that information about the category bias of the ambiguous word is rapidly employed in the resolution of this ambiguity. When the ambiguous word is one that tends statistically to be a verb, readers tend to commit erroneously to the subject-verb interpretation, but when the word tends to occur as a noun, readers show no evidence of misanalysis. MacDonald (1993) has found evidence of more subtle factors, including the relative frequency with which the preceding noun occupies certain phrase-structural positions, the frequency of co-occurrence between the preceding noun and ambiguous word, and semantic fit information. Most importantly for the current work, MacDonald found that when the ambiguous word was preceded by a noun that tended to occur as a phrasal head, readers tended to commit to the subject-verb interpretation. However, when the preceding noun tended to occur as a noun modifier, readers tended to commit immediately to the correct noun-noun compound analysis.

The overall pattern of data suggests a relatively complex interplay of

constraints in the resolution of lexical category ambiguity. Lexically specific information appears to be employed very rapidly and processing commitments appear to be affected by multiple sources of information, including subtle cues like the modifier/head likelihood of a preceding noun.

We examined the ability of the model to resolve lexical category ambiguities by presenting it with strings containing noun/verb ambiguous words, as exemplified by (5).

- (5) a. The emergency *plans* ...
 b. The division *plans* ...

The experiment examined the effect of the category bias of the ambiguous word and the modifier/head likelihood of the preceding noun.

Sixty noun/verb ambiguous words were collected from the training corpus. These words were either biased toward a noun interpretation, biased toward a verb interpretation, or equi-biased (20 of each category). The members of the three categories of bias were matched item-wise for overall training frequency.

Eight nouns were selected from the training corpus to occupy the preceding noun position of the experimental materials. Four of these were nouns that tended to occur as phrasal heads in the corpus (e.g., *division*), and the other four were nouns that tended to occur as noun modifiers in the corpus (e.g., *emergency*). Context nouns were matched pair-wise for overall training frequency.

Experimental items consisted of a determiner, a context noun, and a noun/verb ambiguous item. Each of the eight context nouns was paired with each of the 60 N/V ambiguous items, creating 480 items like those in Table 5. The complete set of materials are described in Kim et al. (in prep.).

Example Item	Context Support	Lexical Category Bias
<i>The emergency plans</i>	Noun	N-Bias
<i>The emergency bid</i>	Noun	EQ-Bias
<i>The emergency pay</i>	Noun	V-Bias
<i>The division plans</i>	Verb	N-Bias
<i>The division bid</i>	Verb	EQ-Bias
<i>The division pay</i>	Verb	V-Bias

Table 5: Examples of materials used to examine the model's resolution of the noun/verb category ambiguity.

The model clearly recognized the target words to be either nouns or verbs. Only 16 out of 480 items were assigned a supertag that was neither a

noun supertag nor a verb supertag. The model's resolution of the noun/verb ambiguity showed effects of the category bias of the ambiguous word and the Head/Modifier likelihood of the preceding noun, both of which have been shown in human processing (Corley 1998, MacDonald 1993). The model showed strong commitments to the contextually supported category for equi-biased words and also for biased words when the context supported the dominant sense of the word. The model had difficulty activating the subordinate sense of biased word, even when supported by context. This is illustrated by examining the activation values of the noun and verb part-of-speech units separately from the rest of the output layer, as shown in Table 6 (Column 3). For biased words occurring in contexts that supported the word's dominant category, the contextually supported part-of-speech unit had higher activation than the contextually unsupported unit for 159 of 160 items (80/80 for N-bias word in N-support context and 79/80 for V-bias word in V-support context). For equi-biased items, the contextually supported unit was more highly active for 130/160 items (68/80 for N-support and 62/80 for V-support). However, for biased words occurring in contexts that support the subordinate category, the model showed difficulty activating the contextually supported unit, with the contextually supported unit showing superior activation for only 47 out of 160 items (46/80 for N-support with V-bias and 11/80 for V-support with N-bias).

Context Type	Verb Bias	Superior Activation contextually supported unit.	Degree of Commitment to Noun Interpretation
N-Support	N-Bias	80/80	0.99
N-Support	EQ-Bias	68/80	0.82
N-Support	V-Bias	11/80	0.50
V-Support	N-Bias	47/80	0.76
V-Support	EQ-Bias	62/80	0.32
V-Support	V-Bias	79/80	0.08

Table 6: The proportion of times that the contextually supported part-of-speech unit was given superior activation for noun/verb ambiguous words in each of six conditions (column 3) and the model's degree of commitment to a Noun analysis (column 4).

We quantified the model's degree of commitment to the noun analysis by dividing the noun unit activation by the total activation across the noun and verb units ($Noun\text{-}Activation / (Noun\text{-}Activation + Verb\text{-}Activation)$). This is summarized in Table 6. The closer this value is to 1.0, the greater the

model's commitment to the noun analysis over the verb analysis, and the closer to 0.0, the greater the commitment to a verb analysis. This value was subjected to an Analysis of Variance with Context (N-Support, V-Support) and Category Bias (N-bias, EQ-bias, V-bias) as factors. The model showed a clear effect of lexical category bias, with N-bias items causing a mean noun commitment of 0.88, EQ-bias items causing 0.57, and V-bias items causing 0.29, $F(2,57) = 58.23$; $p < 0.0001$. Second, there was an effect of context: in the context of N-support nouns, the model tended to commit more strongly to noun analyses (mean noun commitment 0.77) than in the context of V-support nouns (mean noun commitment 0.39), $F(1,57) = 238.01$; $p < 0.0001$. Finally, the model showed an interaction between Context and Category-Bias with a strong tendency to activate a context-supported pattern for words whose bias agreed with the context and for EQ-biased words, but not when the category bias disagreed with the context, $F(2,57) = 0.0001$; $p < 0.0001$.

Interestingly, the interaction between word bias and context resembles the "subordinate bias" effect observed in the semantic aspects of word recognition (Duffy, Morris and Rayner 1988). When semantically ambiguous words are encountered in biasing contexts, the effects of context depend on the nature of the word's bias. When the context supports the subordinate sense of a biased ambiguous word, processing difficulty occurs. When the context supports the dominant sense or when it supports either sense of an equi-biased word, no processing difficulty occurs. Our model shows a qualitatively identical effect with respect to category ambiguity. We take this as further support for the idea, central to lexicalist theories, that lexical and syntactic processing obey many of the same processing principles. On the basis of this kind of effect in the model, we predict that human comprehenders should show subordinate bias effects in materials similar to the ones used here. Furthermore, because the subordinate bias effects found here are quite natural given the model's system of representation and processing, we would expect similar effects to arise in the model and in humans with respect to other syntactic ambiguities that are affected by local left context (see Trueswell 1996, for similar predictions about subordinate bias effects involving the main clause/relative clause ambiguity).

The model's use of fine-grained contextual cues in resolving category ambiguities strongly suggests the viability of using such cues to inform syntactic decisions in human language processing. This goes against suggestions in the literature that such fine-grained information is often too sparse to accurately drive a statistical model of the language (Mitchell et al. 1995, Corley and Crocker 1996). We return to this issue in the next section.

5 General Discussion

In this paper, we have attempted to advance the grammatical coverage and formal specification of Constraint-based Lexicalist models of language comprehension. A convergence of perspectives between constraint-based theory in psycholinguistics and work in theoretical and computational linguistics has supported and guided our proposals. We have attempted to give a concrete description of the syntactic aspects of the CBL theory by attributing to human lexical knowledge the grammatical properties of a wide coverage Lexicalized Tree Adjoining Grammar (Doran et al. 1994). In developing a processing model, we have drawn insight from work on processing with LTAG which suggests that statistical mechanisms for lexical ambiguity resolution may accomplish much of the computation of parsing when applied to rich lexical descriptions like those of LTAG (Srinivas and Joshi 1998). We have incorporated these ideas about grammar and processing into a psychologically motivated model of the grammatical aspects of word recognition, which is wide in grammatical coverage.

The model we describe is general in purpose; it acquires mappings between a large sample of the lexical items of the language and a large number of rich grammatical representations. Its design does not target any particular set of syntactic ambiguities or lexical items. Nevertheless, it is able to qualitatively capture subtle patterns of human processing data, such as the frequency-by-regularity interaction in the NP/S ambiguity (Juliano and Tanenhaus 1993) and the use of fine-grained contextual cues in resolving lexical category ambiguities (MacDonald 1993).

The wide range of grammatical constructions faced by the model and the diversity of its sample of language include much of the complexity of the full language and support the idea that constraint-based models of sentence processing are viable, even on a large grammatical scale. The model provides an alternative to the positions of Mitchell et al. (1995) and Corley and Crocker (1996), which propose statistical processing models with only coarse-grained parameters such as part-of-speech tags. Their argument is that the sparsity of some statistical data causes the fine-grained parameters of constraint-based models to be "difficult to reliably estimate" (Corley and Crocker 1996) and that the large number of constraints in constraint-based models causes the management of all these constraints to be computationally intensive. Such arguments assume that a coarse-grained statistical model is more viable and more 'compact' than a fine-grained model.

The issue of whether fine-grained statistical processing is viable may hinge on some basic computational assumptions. The observation that the sparsity of statistical data affects the performance of statistical processing

systems is certainly valid. But there are a number of reasons why this does not support arguments against fine-grained statistical processing models. First, there is a large class of statistical processing models, including connectionist systems like the one used here, that are well suited to the use of imperfect cues. For instance, a common strategy employed by statistical NLP systems to deal with sparse data is to 'back off' to statistics of a coarser grain. This is often done explicitly, as in verb subcategorization methods, where decisions are conditionalized on lexical information (individual verbs) when the lexical item is common, but are conditionalized on (backed off to) basic category information (all verbs), when the lexical item is rare (Collins 1996). In connectionist systems like ours, statistical back-off is the flip-side of the network's natural tendency to generalize but also to be guided by fine-grained cues when those cues are encountered frequently. Fine grained features of a given input pattern are able to influence behavior when they are encountered frequently, because they are given repeated opportunities to influence connection weights. When such fine-grained features are not encountered often enough, they are overshadowed by coarser-grained input features, which are by their very nature more frequent. Systems like our model can be seen as discovering back-off points. We argue that systems that do such backing off are the appropriate class of system for modeling much of sentence processing. As a back-propagation learning system with multiple grammatical tasks competing for a limited pool of processing resources, our model is essentially built to learn to ignore unreliable cues.

Thus, the interaction between frequency and subcategory that we have discussed emerges naturally in the operation of statistical processing devices like the model described here. Fine-grained information about S-complement verbs is able to guide processing when it is encountered often enough during training to influence connection weights in spite of the dominance of NP-complement signals. The ability of Head/Modifier likelihood cues about nouns to influence connection weights is similarly explained.

In general, we view the sparsity of data as an inescapable aspect of the task of statistical language processing rather than as a difficulty that a system might avoid by retreating to more easily estimable parameters. Even part-of-speech tagging models like Corley and Crocker's (1996) include a lexical component, which computes the likelihood of a lexical item given a candidate part-of-speech for that word, and their model is therefore affected by sparsity of data for individual words—this is true for any tagger based on the dominant Hidden Markov Model framework. Furthermore, as mentioned earlier, work in statistical NLP has increasingly indicated that lexical information is too valuable to ignore in spite of the difficulties it may pose. Techniques that count lexically specific events have generally out-performed

techniques that do not, such as statistical context-free grammar parsing systems (see Marcus 1995). It seems to us that, given a commitment to statistical processing models in general, there is no empirical or principled reason to restrict the granularity of statistical parameters to a particular level, such as the part-of-speech tags of a given corpus. Within the engineering work on part-of-speech tagging, there are a number of different tag-sets, which vary in the granularity of their tags for reasons unconnected to psychological research, so that research does not motivate a psychological commitment to any particular level of granularity. Furthermore, the idea that the language processing system should be capable of counting statistical events at only a single level of granularity seems to be an assumption that is inconsistent with much that is known about cognition, such as the ability of the visual processing system to combine probabilistic cues from many levels of granularity in the recognition of objects. The solution to the data sparsity problem, as manifested in humans and in successful engineering systems, is to adopt the appropriate learning and processing mechanisms for backing off to more reliable statistics when necessary.

We have argued that the complexities of statistical processing over fine-grained lexical information do not warrant the proposal of lexically-blind processing mechanisms in human language comprehension. Although the complexities may be unfamiliar, they are tractable, and there are large pay-offs to dealing with them. An increasingly well-understood class of constraint-satisfaction mechanisms is well suited to recognizing fine-grained lexical patterns and also to backing off to coarser-grained cues when fine-grained data is sparse. The modeling work described here and research in computational linguistics suggests that such mechanisms, when applied to the rich lexical representations of lexicalized grammars, can accomplish a substantial amount of syntactic analysis. Furthermore, the kind of mechanism we describe here shows a pattern of processing that strongly resembles human processing data, suggesting that such mechanisms are good models of human processing of speech and text.

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Event Heads and the Distribution of Psych-Roots*

Martha McGinnis

1 Introduction

Most syntactic accounts of psychological predicates rely on the notion that the arguments within a verb phrase are "equidistant" for purposes of syntactic movement. Such a view was straightforward under the original "flat structure" approach to VP, in which, for example, the direct and indirect objects are both treated as sisters of V. Following extensive work on object asymmetries (Baker 1988, Barss & Lasnik 1986, Bresnan & Moshi 1993, Larson 1988, Marantz 1984, 1993, among others), it is now generally agreed that the verb phrase has an internal hierarchical structure. Nevertheless, unlike raising from one subject position to another, movement of internal arguments to subject position has often been treated as though it cannot be held to a strict locality ("shortest move") condition. Accounts involving nonlocal movement of internal arguments have been especially prevalent in the literature on causative psych-verbs (PsyCaus verbs).¹ My ulterior motive here is to establish that the syntax of psych-predicates actually supports locality in A-movement. The approach sketched below points the way towards overcoming a potential stumbling block for theories of A-movement, making it possible to maintain the strong hypothesis that all syntactic movement respects locality.

2 The T/SM Restriction Without Movement

As a point of departure I take the analysis proposed by Arad (1998, 1999). Arad dispenses with the traditional view that the subject of a PsyCaus predicate originates structurally below the object (Belletti & Rizzi 1988, Pesetsky

*Thanks go to Maya Arad, Heidi Harley, Alec Marantz, Liina Pytkänen, two anonymous reviewers, and the rest of the Lexical Categories reading group at Penn. This work was supported by a postdoctoral fellowship from the Social Sciences and Humanities Research Council of Canada (756-98-0515).

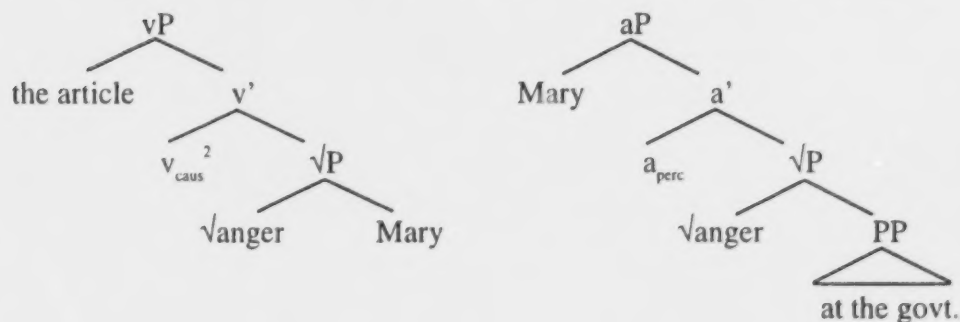
¹PsyCaus predicates correspond to the *preoccupare* class of Belletti & Rizzi (1988). This term distinguishes them from the non-causative *piacere* class. The distinction is important here, so I avoid Pesetsky's (1995) term ObjExp, which groups the two together.

1995). She proposes instead that the subject of a psych-construction is always generated as the highest argument, as in a normal transitive clause, and argues that differences between psych-predicates and transitives arise largely from differences in the aspectual functional heads associated with this highest argument. This proposal has the advantage that it avoids postulating non-local movement of a lower argument past a higher one to the subject position. As we will see, however, one generalization that remains to be captured under such an approach is Pesetsky's T/SM (Target/Subject Matter) restriction. The T/SM restriction is the generalization that a *PsyCaus* verb cannot have both a Causer argument and a Target (1c) or both a Causer and a Subject Matter argument (2c):

- | | | |
|--------|--|----------------|
| (1) a. | Mary was angry <u>at the government</u> . | TARGET |
| b. | <u>The article in <i>The Times</i></u> angered Mary. | CAUSER |
| c. | * <u>The article in <i>The Times</i></u> angered Mary <u>at the government</u> . | |
| (2) a. | Bill was frightened <u>of another tornado</u> . | SUBJECT MATTER |
| b. | <u>The distant rumbling</u> frightened Bill. | CAUSER |
| c. | * <u>The distant rumbling</u> frightened Bill <u>of another tornado</u> . | |

In this paper I contend that the T/SM restriction falls under a broader generalization about causativization. Specifically, I propose that this restriction arises from a morphological distinction between causatives that determine the syntactic category of a predicate, and causatives that are added to a predicate that already has a category. Categorical morphology is here equated with the "event head" of recent literature on lexical semantics (e.g., Harley 1995, Kratzer 1996). Marantz (1997) proposes that a verbal event head merges syntactically with a category-neutral lexical root to produce a phrasal unit; this unit corresponds to what is usually thought of as a "lexical verb." The event head is a functional head that often introduces an external argument, as with causative *v* in (3a). I also adopt Baker's (1997) view that an adjectival predicate can have an external argument, and suggest that this external argument is the specifier of an adjectival event head *a*, as in (3b). We can call the event heads in (3) *root-external*, since they are directly outside the roots; by contrast, a *category-external* event head occurs outside another event head. In English and Japanese, root-external causatives can be spelled out using morphology that is idiosyncratically specified by the root, while category-external causatives use unspecified (default) morphology, which is affixal in Japanese, but not in English. Following Miyagawa (1998), I assume that the default causative morphology in English is the independent phonological word *make*.

- (3) a. The article angered Mary. b. Mary was angry at the government.



I will argue that a predicate containing an Experiencer and a T/SM argument must contain an event head. A causative added to such a predicate will be category-external, allowing only default causative morphology to be used (in English and Japanese). Along with the ill-formed (a) examples in (4) and (5), then, we have the well-formed (b) examples.

- (4) a. * The article in *The Times* angered Mary at the government.
 b. The article in *The Times* made Mary angry at the government.
 (5) a. * The distant rumbling frightened Bill of another tornado.
 b. The distant rumbling made Bill fear another tornado.

3 The Different Flavors of *v*

There are a number of syntactic differences between normal transitives (6a) and PsyCaus predicates (6b), to be discussed in Section 3.1. In accounting for these differences, Arad (1998, 1999) argues that the crucial distinction is in the way the subject is structurally introduced. Suppose that in both cases the subject is generated in the specifier of a light causative verb (*v*). However, in (6a) this verb is eventive, while in (6b), it is stative.

- (6) a. Maria mangia la mela.
 'Maria is eating the apple.'
 b. Questo preoccupa Gianni.
 'This worries Gianni.'

²The different flavours of *v* will be labelled as follows: *v_{ag}* (eventive, agentive *v*: transitives and unergatives), *v_{caus}* (stative causative *v*: PsyCaus verbs), *v_{unacc}* (unaccusative *v*: unaccusatives), and *v_{perc}* (stative perceptive *v*: SubjExp verbs). See below for more detail. I will also assume an adjectival counterpart to *v_{perc}*, *a_{perc}*.

It has been argued in the recent literature that agentive transitive verbs are (at least) bipartite, containing a light causative verb and a lexical base. In some cases, for example, an adverb like *again* can modify either the causing eventuality or the resulting eventuality (von Stechow 1996). Sometimes the causative head is realized by a distinct morpheme (Miyagawa 1994). In English, main verbs are arguably raised to the position of the causative verb, giving the order *I gave John t a book*, instead of **I John gave a book*.³ Marantz (1997) gives a further argument that the causative *v* is a separate syntactic head, based on a contrast between verbal and nominal uses of the same lexical root. Let us go through this argument in some detail, since it introduces some ideas that will be important later on.

The facts under consideration are below. Chomsky (1970) argues that verbs, such as *destroy* or *grow*, share a basic (root) component with their "derived" nominalizations, *destruction* or *growth*. Now consider the argument-taking properties of the roots $\sqrt{\text{destr-}}$ and $\sqrt{\text{grow}}$ in their verbal and nominal contexts. The verb *destroy* must be transitive (7a-b), while *grow* can be transitive or unaccusative (7c-d). The usual account of the alternation in (7c-d) is that *grow* is basically unaccusative, but can have a causative element added to it, which introduces an agentive argument.

- (7) a. The army destroyed the city.
 b. * The city destroyed.⁴
 c. John grew tomatoes.
 d. Tomatoes grew.

The noun *destruction* can take a causative possessor, as shown in (8a), but *growth* cannot (8c). Marantz proposes that a derived nominalization places a category-neutral lexical root such as $\sqrt{\text{destr-}}$ or $\sqrt{\text{grow}}$ in a nominal syntactic context (e.g., sister of D). He locates the crucial distinction between the roots $\sqrt{\text{destr-}}$ and $\sqrt{\text{grow}}$ in their intrinsic semantics; $\sqrt{\text{grow}}$ denotes an internally-caused change of state, while $\sqrt{\text{destr-}}$ is not internally caused. Marantz proposes that this difference in interpretation is responsible for differences in their syntactic distribution.

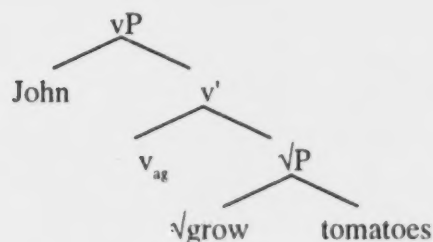
³This argument is based on a similar argument for raising to *v* in Collins (1997). Pesetsky (1989), Johnson (1991), and Koizumi (1993) provide more extensive evidence for verb raising in English.

⁴The string (7b) is possible under a 'middle' interpretation, which I assume involves a causative *v* head, like (7a). See Embick (1997) for discussion.

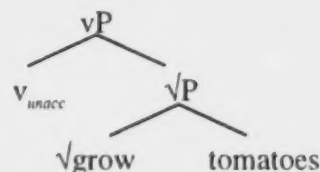
- (8) a. the army's destruction of the city
 b. the city's destruction
 c. * John's growth of tomatoes
 d. tomatoes' growth

In addition to the differences that arise in the nominalization context, $\sqrt{\text{grow}}$ can either take an agentive subject in the verbal context (9a), or not (9b). Marantz argues that the agent is introduced by the causative verb v . $\sqrt{\text{Grow}}$ cannot take a causative possessor in the derived-nominal context (9c), since in this context there is no v to introduce one. Of course, the derived nominal without a possessor is fine (9d).

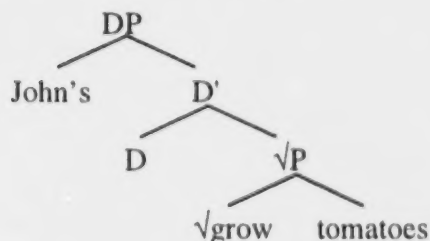
- (9) a. John grows tomatoes.



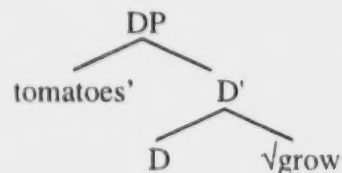
- b. Tomatoes grow.



- c. * John's growth of tomatoes



- d. tomatoes' growth

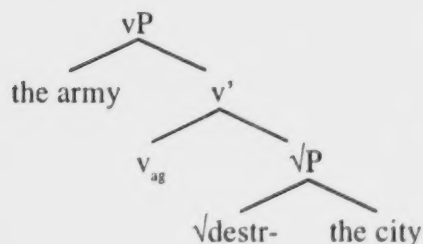


By contrast, $\sqrt{\text{destr-}}$ can take a causative possessor in the nominal context. Marantz suggests that this option is available because the causative interpretation is recoverable from the semantics of the externally-caused root (10c). The robustly causative connotations of $\sqrt{\text{destr-}}$ are also responsible for the fact that it must occur with agentive v in the verbal context (10a-b).⁵

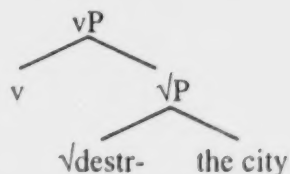
⁵As Noyer & Harley (1997) observe, other verbs that allow the causative possessor are not as strongly causative, and thus need not occur with agentive v in the verbal

However, the causative possessor can be absent from the nominal context, since v_{ag} is absent from this context (10d).

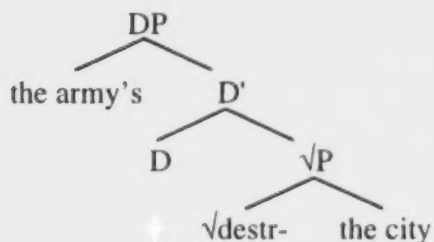
(10) a. The army destroyed the city.



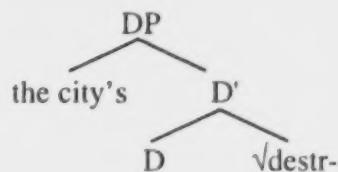
b. * The city destroyed.



c. the army's destruction of the city



d. the city's destruction



Consider the implications of the verbal and nominal facts taken together. The nominal counterpart of a causative verb like *destroy* can have a causative possessor, but the nominal counterpart of *grow* cannot, even though $\sqrt{\text{grow}}$ can occur in a causative context. If the causative element could be added to $\sqrt{\text{grow}}$ in the lexicon, the newly-minted causative should be able to appear in a nominal context, allowing an agentive possessor just like the nominalized causative *destruction*. However, if the causative is a v head added in the syntax, then the full range of facts can be explained, as above.

In summary, there is considerable evidence that agentive transitives contain a light causative verb and a lexical base, which I will assume here is a category-neutral root. Pylkkänen (1998) provides a wealth of evidence from Finnish that *PsyCaus* verbs also have a two-part structure. For example, the adverb *melkein* 'almost' can modify either the causing eventuality or the resulting eventuality. Thus, (11a) can either mean that *Matti* did something or had some property that almost caused a state of disgust in *Maija* (i.e., the

context. For example, *The army's explosion of the bridge* is possible, but also *The bridge exploded*.

mental state almost held), or that *Matti* almost did something or had some property that would have caused a state of disgust in *Maija* (i.e., the causing event almost occurred). Moreover, a PsyCaus verb in Finnish has causative morphology; compare the causative in (9a) with the noncausative subject-experiencer verb in (11b), where reportedly *melkein* introduces no ambiguity. The causative morphology in (11a) is also used with derived agentive verbs (11c).

- (11) a. Matti melkein inho-tti Maija-a.
 M.-NOM almost find.disgusting-CAUS.PAST M.-PAR
 'Matti almost disgusted Maija.'
- b. Maija melkein inhoa-a Matti-a.
 M.-NOM almost find.disgusting-3SG M.-PAR
 'Maija almost found Matti disgusting.'
- c. Pekka hajo-tti lasi-n.
 P.-NOM break-CAUS.PAST glass-ACC
 'Pekka broke the glass.'

The semantic and morphological facts of Finnish support a bipartite structure for PsyCaus predicates. To these facts we can also add the counterpart of Marantz's argument from nominalizations: Chomsky (1970) points out that certain psych-predicates resemble predicates like *grow*, in that they can occur with a causative subject in the verbal context (12a), but cannot take a causative possessor in the nominal context (13a).⁶

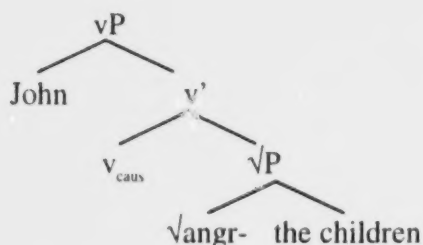
- (12) a. John angered the children.
 b. The children were angry.
- (13) a. * John's anger of the children
 b. the children's anger

If we adopt Marantz's approach for these facts as well, we may conclude that a causative interpretation cannot be recovered from the root $\sqrt{\text{anger}}$, but a causer can be added to this root syntactically, by means of a light verb. Thus we have evidence that a light causative verb is present in both agentive tran-

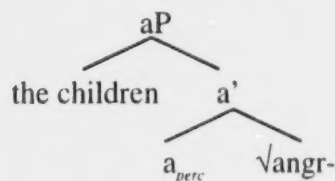
⁶It is worth pointing out that the English causative in (12a) can be either stative or eventive. The reading of most interest for the purposes of this discussion is the stative one, where John may or may not have been doing anything to anger the children—for example, if just the sight of him was enough to make them angry. Statives in Finnish are discussed below.

sitives and psych-predicates. The structure of (12b), shown in (14b), is not exactly parallel to that of the unaccusative $\sqrt{\text{grow}}$ in (9b); we will return to this point later.

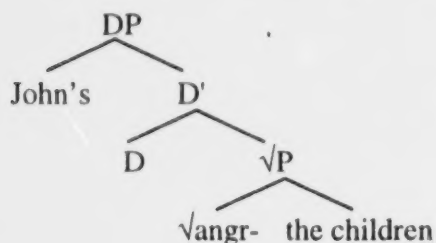
(14) a. John angered the children.



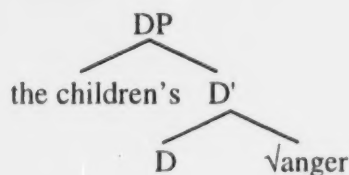
b. The children were angry.



c. * John's anger of the children



d. the children's anger



In order to account for various syntactic differences between agentive transitives and psych-predicates, Arad (1998, 1999) argues that they involve different types of causative verbs, as noted above. Pylkkänen (1998) provides evidence from Finnish that psych-predicates involve a stative causative verb, rather than the eventive causative used in agentive transitives. The reader is referred to Pylkkänen's paper for details, but a brief review follows. The object of a *PsyCaus* verb in Finnish has partitive case, indicating atelicity.⁷ *PsyCaus* verbs also demonstrate other stative characteristics—for example, they receive a habitual interpretation in the present tense, and resist the progressive. An agentive transitive verb can occur in the progressive, though its ob-

⁷There is also a class of causative psych-verbs that allows an ACC object (i); this case-marking pattern corresponds to a non-stative interpretation. Arad gives extensive evidence from Italian that some psych-roots can combine with either the eventive or the stative causative *v*.

(i) Uutiset viha-stu-tti-vat Mikko-a/Mikko-n.
 news.NOM anger-INCH-CAUS.PAST-3PL M.-PAR/ACC
 'The news made Mikko become angry.'

ject then takes on partitive case (15a). A prototypical stative verb in Finnish cannot occur in the progressive (15b), nor can a PsyCaus verb (15c).

- (15) a. Mikko on maalaa-ma-ssa talo-a.
 M.-NOM is paint-INF-INESS house-PAR
 'Mikko is painting a house.'
- b. * Pekka on osaa-ma-ssa ranska-a.
 P.-NOM is know-INF-INESS French-PAR
 'Pekka is knowing French.'
- c. * Kaisa on sääli-ttä-mä-ssä Matti-a.
 K.-NOM is pity-CAUS-INF-INESS M.-PAR
 'Kaisa is causing pity in Matti.'

These facts provide evidence that psych-roots combine with a stative light causative verb, which has different syntactic properties from the eventive light causative verb used in agentive transitives. Arad (1999) argues that this difference in causative verb types is partially responsible for the classic "psych-effects" as well.⁸ As we will see, Arad's generalization has certain key empirical advantages over other accounts of psych-effects in the literature.

3.1 Psych-Effects

Belletti & Rizzi (1988; B&R) identify a collection of differences between PsyCaus predicates, which have an Experiencer object, and predicates with an Experiencer subject (SubjExp predicates), which have the syntax of regular transitives. One such difference is the familiar "backward binding" phenomenon (Akatsuka 1976, Giorgi 1984, Pesetsky 1987). Unexpectedly, the object of a PsyCaus verb, such as *worry*, can bind an anaphor embedded in the subject (16a, 16c). The same is not true for other transitives, as shown by the contrasting examples in (16b, 16d). Similar facts obtain in Italian, as B&R demonstrate.

- (16) a. These rumors about himself worry John more than anything else.
 b. * These rumors about himself describe John better than anything else.

⁸More accurately, she proposes that these effects are associated with a stative causative verb assigning accusative case in Italian. There is also a class of psychological predicates (B&R's *piacere* class) with DAT and NOM arguments.

- c. Each other's supporters worried Freud and Jung.
- d. * Each other's supporters telephoned Freud and Jung.

Two other restrictions on PsyCaus verbs can be seen in (17) and (18). Transitive verbs can occur in a construction with a reflexive clitic (17a), and can also take an arbitrary *pro* subject (18a). Clauses with a "derived" subject (passives and unaccusatives) are incompatible with both, as illustrated in (17b) and (18b). PsyCaus verbs (the *preoccupare* 'worry' class) pattern with passives and unaccusatives in this respect, as shown in the (c) examples.

- (17) a. Gianni si è fotografato.
'Gianni photographed himself.'
- b. * Gianni si è stato affidato.
'Gianni was entrusted to himself.'
- c. * Gianni si preoccupa.
'Gianni worries himself.'
- (18) a. *pro* ti stanno chiamando.
'Somebody is calling you.'
- b. * *pro* sono arrivati a casa mia.
'Somebody arrived at my place.'
- c. * Evidentemente, in questo paese per anni *pro* hanno preoccupato
 il governo.
'Evidently, in this country people worried the government for
 years.'

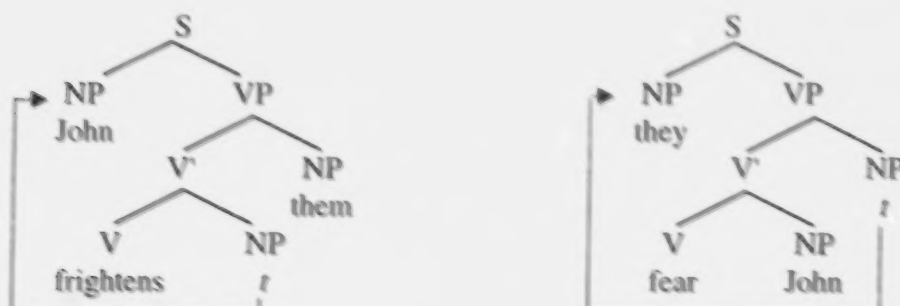
Psych-predicates have another distinctive property, which can be described in several ways. One way of putting it is as follows (Pylkkänen 1998). A causativized unaccusative increases in "valency," permitting an additional argument (19), while a causativized psych-predicate does not increase in valency (20). (20a) is a SubjExp predicate. In its causative counterpart (20b), the Experiencer is the object, but the other argument, *at John*, can no longer be expressed. It has been argued (B&R, Pylkkänen 1998) that this contrast arises because the added argument in (19b) adds a new semantic role, while in (20b) it has the same semantic role as one of the existing arguments (here, *at John*). The impossibility of (20b) then follows from the traditional assumption that a single semantic role cannot be expressed by two ar-

guments of the same verb.⁴ Pesetsky (1995) takes a different approach to this restriction, to which we return below.

- (19) a. Tomatoes grew.
 b. John CAUS+grew tomatoes.
 (20) a. The children were angry at John.
 b. Mary CAUS+angered the children (*at John).

B&R's account of the psych-effects is as follows. By their view, normal transitives (including SubjExp verbs) have an underlying external argument, while PsyCaus verbs have an unaccusative structure with a derived subject. Under this view, the similarities between PsyCaus structures, passives, and unaccusatives follow from the presence of a derived subject, and the backward binding effects are attributed to the base position of the derived subject. B&R propose that the subject of a PsyCaus verb originates below the Experiencer object (21a). Thus, they claim, the Experiencer can bind an anaphor embedded within the derived subject before it raises to the subject position.

- (21) a. John frightens them. b. They fear John.



The base order of the arguments is determined by their theta-roles. B&R take the position that the subject of a PsyCaus predicate is a Theme, while the object is an Experiencer. These are the same thematic roles they associate with SubjExp predicates, which pattern with transitives throughout. B&R argue that a Theme is always generated below an Experiencer argument of the same verb. When the Experiencer has inherent Case, the Theme raises to

⁴Note that the PP "argument" of a SubjExp predicate can be omitted, like an adjunct. I follow Pesetsky in assuming that optional PP arguments of SubjExp predicates (like *be angry*) have essentially the same syntactic status as obligatory DP objects of SubjExp predicates (like *fear*). Thanks to Heidi Harley for raising this point.

the subject position, and a PsyCaus predicate results (21a). Otherwise, both arguments have structural Case, and the Experiencer is an external argument, yielding a SubjExp predicate (21b). As noted above, this approach provides a semantic account of (20b); two arguments are said to bear the Theme role, so the structure is ill-formed.

Nevertheless, a number of problems with this account of psych-predicates have been pointed out in the literature. For one thing, a Case-based explanation of the differences between SubjExp and PsyCaus predicates does not explain the causative interpretation of the latter, or the causative morphology seen in Finnish. For another, movement of the lower Theme past the higher Experiencer to the subject position seems to violate relativized minimality (Rizzi 1990) or "attract closest" (Chomsky 1995).¹⁰ There are also several key ways in which PsyCaus predicates fail to pattern with passives and unaccusatives. For instance, the Experiencer object of a PsyCaus predicate in Italian has accusative morphological case, just as in a transitive. Moreover, the aspectual auxiliary used with a PsyCaus verb is *avere* 'have,' as with a transitive verb, while the auxiliary used with unaccusatives is *essere* 'be.' Pesetsky (1995) proposes an account that undertakes to explain both the differences and the similarities between transitives and PsyCaus predicates. The next subsection briefly summarizes the part of this account that is consistent with Arad's 'flavors of *v*' approach, adopted here. The remainder of the section concerns the remainder of Pesetsky's account, to which this paper proposes an alternative.

3.2 Towards Locality-Compliance

Pesetsky (1995) takes the first steps towards the view that the derivation of PsyCaus predicates respects locality. He argues that PsyCaus predicates actually do have an external argument, namely the Causer. This argument has a different semantic role from the object of a SubjExp verb, which Pesetsky calls the Target or Subject Matter. The differences in interpretation can be seen in (22) and (23). In (22a), *the article* is the Target of *Bill's* anger; for example, he might be angry because it panned his new book. However, (22a) could not be used to describe a situation in which Bill found the article itself irreproachable, but its contents caused him to be angry at the government. (22b), on the other hand, could be used to describe such a situation: "The

¹⁰ A lower argument can A-move past a higher one under certain circumstances (McGinnis 1998a), but such movement has consequences for binding that seem not to arise with PsyCaus verbs, as we will see below.

article does cause Bill to be angry, and possibly angry at someone or something, but he is not necessarily angry at the article itself" (Pesetsky 1995: 56).

- (22) a. Bill was very angry at the article in *The Times*.
- b. The article in *The Times* angered/enraged Bill.

Similarly, in (23a), *the television set* is the Subject Matter of John's worry—for example, he might be worried because it is in a precarious position. This sentence could not be used to describe a neurotic situation in which John experienced an ill-defined anxiety about his life in general whenever he saw or thought about the television set. Such a reading is possible in (23b), where "the television set causes John to experience worry, but the Subject Matter of his thoughts while experiencing worry could have nothing to do with the television set" (Pesetsky 1995: 57).

- (23) a. John worried about the television set.
- b. The television set worried John.

If PsyCaus predicates have a Causer external argument, then their differences from normal transitives cannot follow from the absence of such an argument. Indeed, Pesetsky shows that one psych-effect, found in PsyCaus passives, can be attributed to the stative/eventive distinction between PsyCaus predicates and normal transitives. B&R note that PsyCaus verbs allow a passive use. Since verbal passivization would be incompatible with the unaccusative analysis, they propose that this passive is adjectival. Unlike eventive verbal passives (24a), and like clearly adjectival passives (24b), passives of PsyCaus verbs cannot occur in the progressive (24c) (Grimshaw 1991). However, Pesetsky points out that stative passives in general disallow the progressive. This generalization includes passives of SubjExp verbs, which have an external argument (24d).

- (24) a. The city is being destroyed by the soldiers.
- b. * The book was being very abridged.
- c. * Mary was being depressed by the situation.
- d. * This performance is being liked by Bill.

Pesetsky shows that backward binding also fails to support the unaccusative analysis, since this effect arises even when the subject originates above the object. As we saw above, unlike eventive transitives (25a), PsyCaus verbs (25b) allow backward binding. However, the same effects obtain if a causa-

tive verb like *make* is used with a SubjExp complement (25c-d). Here the subject clearly originates in a higher position than the Experiencer argument, yet backward binding is possible.¹¹

- (25) a. * Each other's supporters telephoned *Freud and Jung*.
 b. Each other's supporters worried *Freud and Jung*.
 c. Each other's supporters made [*Freud and Jung* angry].
 d. Each other's supporters made [*Freud and Jung* seem [*t* to be angry]].

The unavailability of the reflexive clitic derivation also fails to support the derived subject analysis. B&R propose that (26) is ill-formed because it involves movement of *Gianni* from below *si* to above *si*.

- (26) * *Gianni si preoccupa t*.
 'Gianni worries himself.'

This derivation is said to be ungrammatical because of a chain formation algorithm that prevents an anaphor from occurring in an intervening position in the chain between an argument and its trace—see (27), where left-to-right order represents c-command (Rizzi 1986).

- (27) * [NP_i , ..., anaphor_{*i*}, ..., t_i]

As Pesetsky notes, this condition cannot apply as stated, since there is considerable evidence that the well-formed derivation of a transitive clause with *si* does involve the configuration in (27), with the surface subject raising from the object position, as in a passive (Marantz 1984, Kayne 1986). In (28), the reflexive clitic is actually the external argument, but it fails to become the syntactic subject, at least in part because it lacks Case (McGinnis 1998a).

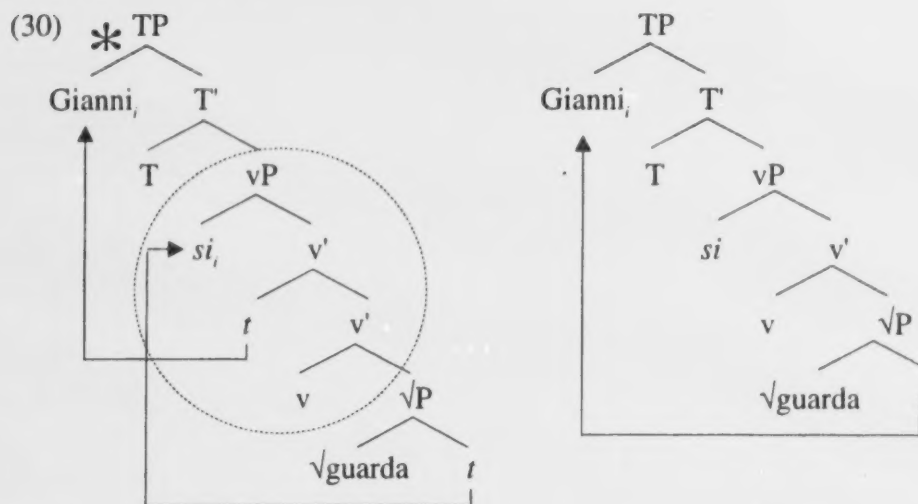
- (28) a. *Gianni si guarda t*.
 'Gianni watches himself.'
 b. *Gianni si teme t*.
 'Gianni fears himself.'

¹¹Pesetsky demonstrates that another psych-effect, the impossibility of an arbitrary *pro* subject, arises from semantic restrictions that cross-cut the unaccusative/transitive distinction.

In providing an account of the passive-like derivation of (24b), Marantz (1984) raises the question of why this account should be necessary: why is it impossible to generate *si* as an accusative object clitic, and *Gianni* as the external argument? The derivation in (28b) is actually forced by a condition very like Rizzi's chain formation algorithm (McGinnis 1998a, 1998b; cf. Snyder 1992). This condition is stated in (29).

- (29) *Lethal Ambiguity*: An anaphoric dependency cannot be established between two specifiers of the same head.

Under the account of Case-checking in Chomsky (1995), the object of a transitive clause checks Case on *v*. If the object is a clitic, it checks Case overtly, in a specifier of *v*P (30a). The external argument is base-generated in a specifier of *v*P. As a result, a reflexive clitic object would always violate Lethal Ambiguity, since the anaphor and its binder would occupy specifiers of the same head at one point in the derivation. Thus the only available derivation is the one in which the reflexive clitic is a Caseless external argument, allowing the passive-like derivation (30b).



Kayne suggests the descriptive generalization that the (Caseless) reflexive *si* is always an external argument. Given the view adopted here—that the Causer of a PsyCaus predicate is an external argument too—we must be more specific, and say that reflexive *si* can be generated only in the specifier of *certain* light verbs. One such verb is the eventive causative *v*, as in (28a). Another would be the stative, non-causative *v* used with SubjExp verbs, as in

(28b).¹² However, as we have seen, Caseless *si* cannot appear with the stative, causative *v* (26), or in passives and unaccusatives (as shown in (17)).

In summary, Pesetsky's arguments largely undercut the motivation for a locality-violating account of PsyCaus predicates. He shows that many of the psych-effects attributed to the unaccusative derivation properly belong to other generalizations. Because he treats the Causer subject of a PsyCaus predicate as semantically distinct from the T/SM object of a SubjExp predicate, it should in principle be possible to generate all Causers above Experiencers, and all T/SM arguments below Experiencers. This is essentially the approach of Arad (1998, 1999). However, Pesetsky notes that such an approach leaves an important generalization unexplained, namely the T/SM restriction. In what follows, I will review the T/SM restriction and Pesetsky's account of it, in preparation for the alternative account to be proposed here.

3.3 The T/SM Restriction

Under Pesetsky's account of PsyCaus and SubjExp predicates, the former involve a Causer and an Experiencer, while the latter involve an Experiencer, and possibly a Target or Subject Matter argument. Pesetsky's claim that the Causer and the T/SM theta-roles are distinct raises the question of why the two cannot co-occur, as shown in (1) and (2), repeated below. This co-occurrence restriction is what Pesetsky calls the T/SM restriction.

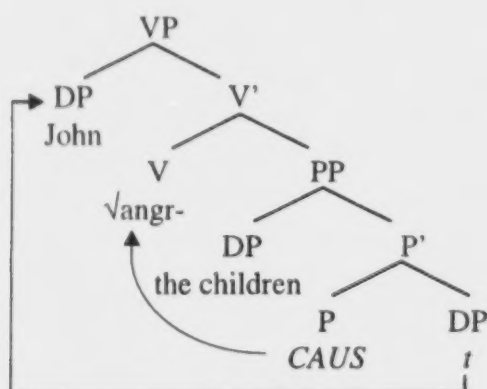
- (1) a. Mary was angry at the government.
- b. The article in *The Times* angered Mary.
- c. * The article in *The Times* angered Mary at the government.
- (2) a. Bill was frightened of another tornado.
- b. The distant rumbling frightened Bill.

In accounting for the T/SM restriction, Pesetsky proposes that the Causer of a PsyCaus predicate is actually a *derived* external argument. The Causer originates below the Experiencer, like a T/SM argument, as the object of a

¹²Arad (1997) notes that *si* is also possible with B&R's *piacere* class, which is usually treated as an ObjExp class because it has a dative Experiencer. However, Alec Marantz (class notes, 1999) suggests that the *piacere* class may have a SubjExp derivation, with a quirky dative Experiencer subject. If so, the possibility of *si* with these verbs can be attributed to the presence of the stative noncausative SubjExp *v*, as in (24c), except that here this *v* is also responsible for quirky dative case on the Experiencer.

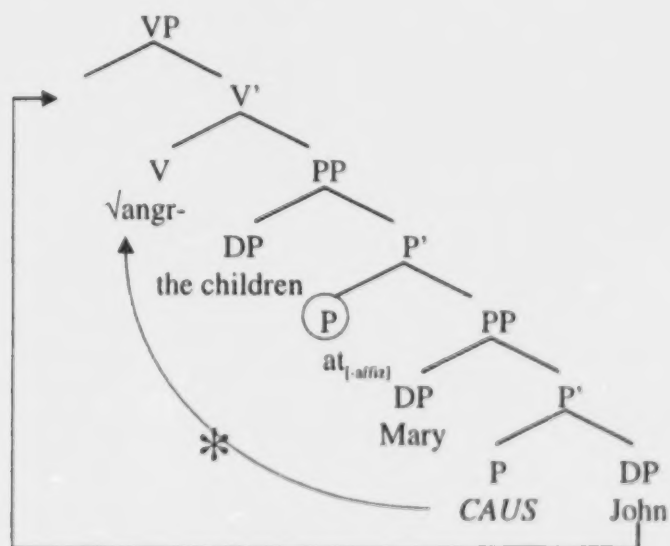
causative preposition *CAUS*. It then raises to a theta-position (also Causer) above the Experiencer. *CAUS* is affixal, and must attach to the verb syntactically (31).

(31) John angered the children.



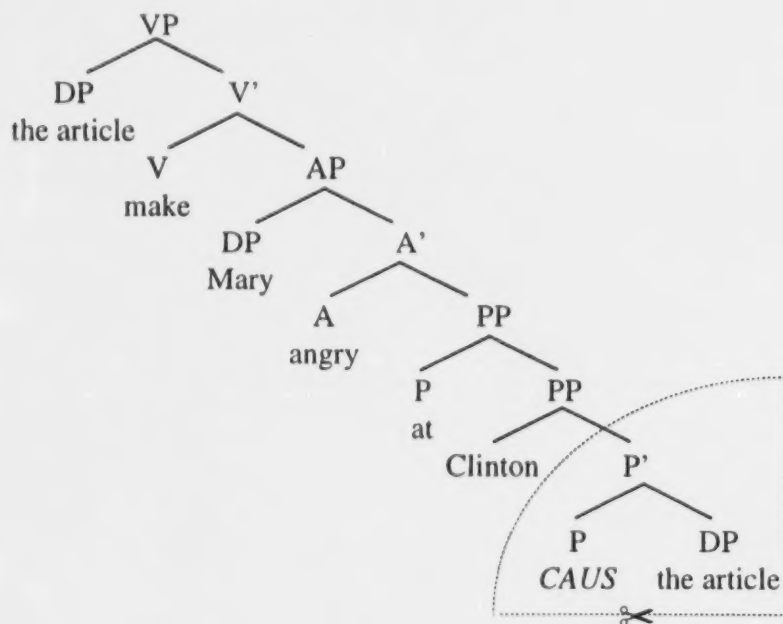
This proposal yields one possible account of the T/SM restriction. Suppose the T/SM argument receives its Case and theta-role from a preposition that intervenes between the main verb and the *CAUS* preposition, as shown in (28). If this preposition is not affixal, and cannot raise to V, it will block movement of *CAUS* to V. In accordance with locality, *CAUS* cannot skip over the preposition to V, so the derivation is ill-formed (32).

(32) * John angered the children at Mary.



Pesetsky argues that the possibility of backward binding with *PsyCaus* predicates arises from movement of the Causer from a position c-commanded by the Experiencer to a position c-commanding it. However, as noted above, backward binding also occurs in periphrastic psychological causatives, when there is no such movement. In these cases, Pesetsky suggests, backward binding is licensed by semantic identity between the external argument and the object of *CAUS*. Here, however, the *CAUS*-PP, including the lower Causer, can be freely deleted, since they add nothing to the causative interpretation of *make* (33). Deletion of the *CAUS*-PP makes it possible to have a T/SM argument as well as a Causer argument in these cases (34).

(33) The article made Mary angry at Clinton.



- (34) a. The article in *The Times* made Mary angry at the government.
 b. The distant rumbling made Bill frightened of another tornado.

As Pesetsky notes, this movement (or movement-like) theory of backward binding effects seems more principled than the descriptive generalization in (35).

- (35) A Causer argument of a predicate π may behave as if c-commanded by an argumental DP governed by π . (Pesetsky 1995:49)

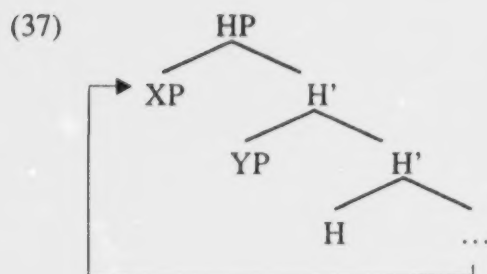
However, there is reason to doubt that the movement account of (35) can be maintained. Note that Pesetsky's account of the backward binding effects assumes that a PsyCaus predicate such as (31) contains no higher causative verb. The CAUS-PP alone is said to be responsible for the causative interpretation of such predicates, so it cannot be deleted in (32). However, as we saw in Section 2, there is evidence that PsyCaus predicates *do* contain a light causative verb. Thus the contrast between periphrastic causatives and PsyCaus predicates remains unexplained. Arguably, then, the movement account does not improve empirically on the descriptive generalization in (35).

Another problem posed by the movement account is that the Causer violates the locality condition on syntactic movement. Although the proposed derivation of (31) involves an unusual kind of movement, namely movement from one theta-position to another, we would still expect it to respect locality. That is, we would expect only the higher argument, the Experiencer, to be able to move to the higher Causer theta-position. Such a derivation might fail for Case reasons: the Experiencer would be unable to move to the higher Causer position because it has already checked (accusative) Case. This derivation would then be parallel to the ill-formed "superraising" derivation (36), in which neither of the arguments in the embedded clause can raise to the subject position of the matrix clause. Movement of the higher argument *it* is blocked because this argument has already checked Case. Movement of the lower argument is blocked because of locality, since the *it* is closer to the matrix subject position.

(36) * [____ seems [(that) *it* was told *John* [that time was up]]].

Alternatively, we might suppose that the Experiencer can successfully move to the higher Causer position, but that this derivation converges as gibberish, given that the same argument has two theta-roles, and a single theta-role (Causer) is shared by two arguments.

Instead, the derivation in (31) has a lower argument skipping over the higher one to the subject position. Movement of a lower argument past a higher one is in principle compatible with locality, but only if the lower argument "leapfrogs" over the higher one. Let us assume, for concreteness, that an argument XP can leapfrog over a higher argument YP only if it first moves to a position where XP and YP occupy specifiers of the same head (Ura 1996), as shown in (37). The two specifiers are then "equidistant" for the purposes of locality. As noted above, however, an anaphoric dependency cannot obtain between specifiers of the same head.



In Japanese, for example, an object can undergo A-movement to a position where it c-commands the subject. From this position, it can bind into the subject (38a), but cannot bind the subject directly (38b). A similar situation arises if a direct object scrambles past an indirect object to a position above the subject. The scrambled direct object can bind an anaphor embedded in the indirect object (39a). However, since it must leapfrog over the indirect object in order to move to its final scrambled position, the direct object cannot bind the indirect object directly (39b). The observations in (38)-(39) are from Yatsushiro (1997 and p.c.)

- (38) a. **Hiroshi-o** [*karezisin-no hahaoya*]-ga [*t* nagutta].
 H.-ACC self-GEN mother-NOM hit.PST
 'His_i mother hit **Hiroshi_i**.'
- b. * **Hiroshi-o** *karezisin-ga* [*t* nagutta].
 H.-ACC self-NOM hit.PST
 'Himself_i hit **Hiroshi_i**.'
- (39) a. **Osamu-o** Kazuko-ga [*t* [*karezisin-no hahaoya-ni*][*t* miseta]].
 O.-ACC K.-NOM self-GEN mother-DAT showed
 'Kazuko showed **Osamu_i** to his_i mother.'
- b. * **Osamu-o** Kazuko-ga (*kagami-o tukatte*) [*t karezisin-ni* [*t* miseta]].
 O.-ACC K.-NOM mirror-ACC using self-DAT showed
 'Kazuko showed **Osamu_i** to himself_i (using a mirror).'

However, the subject of a PsyCaus predicate can bind the object, suggesting that the two never occupy specifiers of the same head (40). These examples appear to be acceptable on both an eventive agentive reading and a stative PsyCaus reading. Thus, if the Causer subject were to originate below the Experiencer, it could only move to the subject position by skipping over the intervening argument. Such a derivation would violate locality: the Expe-

riencer should block movement of the Causer to the external argument position.

- (40) a. John frightens himself.
 b. Taroo-ga zibunzisin-o odorok-asi-ta.
 T.-NOM self-ACC surprise-CAUS-PAST
 'Taroo surprised himself.'

In their discussion of reflexive clitics and PsyCaus verbs, B&R note that binding is much improved with non-clitic anaphors. They propose that such anaphors can receive a "focal" interpretation, and that focused anaphors are, in effect, immune to the effects of Lethal Ambiguity (29) (or, equivalently here, Rizzi's chain formation algorithm). However, this account does not explain why the (b) examples of (38)-(39) are ill-formed.¹³

Although there may be some way to make the movement account of PsyCaus predicates consistent with the above observations, I take these observations as reasonable grounds for seeking an alternative. The 'flavors of little v' approach adopted here captures many of the same facts as Pesetsky's account, though so far it offers no explanation of the T/SM restriction. The remainder of this paper is devoted to an account of the T/SM restriction that does not appeal to movement of the Causer from a position below the Experiencer.

4 Root-External and Category-External Causatives

As mentioned in the previous section, psychological causatives with *make* (41) and PsyCaus verbs (42) differ with regard to the T/SM restriction:

- (41) a. * The article in *The Times* angered Mary at the government.
 b. * The distant rumbling frightened Bill of another tornado.
 (42) a. The article in *The Times* made Mary angry at the government.
 b. The distant rumbling made Bill frightened of another tornado.

¹³This said, there are apparently some cases in which the Experiencer cannot be bound by the Causer. For example, consider (i)-(ii) from Finnish (Liina Pykkänen, p.c.). At the moment I have no explanation for such cases.

(i)?? Pekka inho-tta-a itseään. (ii)?? Pekka sure-tta-a itseään.
 Pekka disgust-CAUS-3SG self.PART Pekka be.sad-CAUS-3SG self.PART
 'Pekka disgusts himself.' 'Pekka makes himself sad.'

I will argue here that this contrast arises from the distinction between root-external and category-external causatives. I assume that a verb consists of (at least) a category-neutral root plus a root-external (category-determining) event head, *v*. The proposal here will be that the examples in (41) involve just a root-external causative *v*, while those in (42) involve a root-external *v* plus a category-external causative *v*. Root-external causatives have sometimes been called "monoclausal," and category-external causatives "biclausal" (Harley 1995).¹⁴

These two types of causatives have different semantic and morphological properties (Miyagawa 1980, 1989, 1994, 1998, etc.; Marantz 1997). First of all, the interpretation of root-external causatives is usually described as involving a more "manipulative" notion of causation than that of category-external causatives. Moreover, idioms can include a single causative *v*, but cannot cross the *v* boundary (Marantz 1997). Thus there are idioms based on a root-external causative, but no category-external causative idioms, in which both causative *v* heads are necessary to form the idiom. (43a) is a root-external causative idiom, with only a single *v* head; the noncausative counterpart has no idiomatic interpretation (43b) (Miyagawa 1980).

- (43) a. Taro-ga zisyoku-o niow-ase-ta.
 T.-NOM resignation-ACC smell-CAUS-PAST
 'Taro hinted that he might resign.'
 (lit. 'Taro caused resignation to smell.')
- b. Zisyoku-ga nio-u.
 resignation-NOM smell-PRES
 'Resignation smells; *Resignation is hinted.'

Looking at French and English, Ruwet (1991) points out that a causative can only be idiomatic if the lower verb is non-agentive. Thus, for example, *make ends meet* is a possible idiom, because *meet* does not have an agentive meaning. By hypothesis, this is a root-external causative, with only a single event head. A category-external causative, like *make X eat cake*, can apparently never have an idiomatic reading that is absent when the higher causative is removed.

In some cases, the two types of causatives can be distinguished morphologically. In English and Japanese, for example, the morphology used for

¹⁴Miyagawa (1998) suggests that biclausal causatives actually involve two Tense heads as well as two *v* heads. I leave this issue for further investigation.

root-external causative *v* is idiosyncratic, varying as a function of the choice of lexical root, while such variation is not observed in category-external causatives. For example, consider the Japanese verbs in (44) (taken from Jacobsen 1992). These verbs illustrate a causative/inchoative alternation, in which the event head *v* is associated with overt morphology (Harley 1995, Nishiyama 1998). On the left are unaccusative verbs, whose event head is noncausative, and does not introduce an external argument. On the right are transitive verbs, whose causative event head generally does introduce an external argument. The causative morphology here varies idiosyncratically with the lexical root.

- | | | | | |
|---------|------------|-------------------------|----------|-----------------------|
| (44) a. | ag-ar-u | 'rise' | ag-e-ru | 'raise' |
| b. | hazu-re-ru | 'come off' | hasu-s-u | 'take off' |
| c. | kog-e-ru | 'become scorched' | kog-as-u | 'scorch' |
| d. | nar-Ø-u | 'ring _{intr} ' | nar-as-u | 'ring _{tr} ' |
| e. | ak-Ø-u | 'open _{intr} ' | ak-e-ru | 'open _{tr} ' |
| f. | kir-e-ru | 'be cut' | kir-Ø-u | 'cut' |

By contrast, for a category-external causative, the regular suffix *-(s)ase* is used.¹⁵ Following Miyagawa (1998), I assume that *-(s)ase* spells out a causative event head (*v*). (45) illustrates cases in which two causative *v* heads attach to the category-neutral root. In (45a), the root-external causative is realized as *-(s)as*; in (45b), it is pronounced *-(s)ase*; in (45c), it is phonologically empty. In each case, the category-external causative is morphologically realized as *-(s)ase*; idiosyncratic causative morphology cannot be inserted outside causative *v*.

- (45) a. Taroo-ga Hanako-ni kodomo-tatf-o ugok-as-ase-ta.
 T.-NOM H.-DAT kids-ACC move-CAUS-CAUS-PAST
 'Taro made Hanako cause the kids to move.'
- b. Hanako-ga Taroo-ni Ziroo-o Mitiko-ni aw-ase-sase-ru.
 H.-NOM T.-DAT Z.-ACC M.-DAT meet-CAUS-CAUS-PRES
 'Hanako will cause Taro to make Jiro meet Michiko.'
- c. Hanako-ga Taroo-ni piza-o tabe-Ø-sase-ta.
 H.-NOM T.-DAT pizza-ACC eat-CAUS-CAUS-PAST
 'Hanako made Taro eat pizza.'

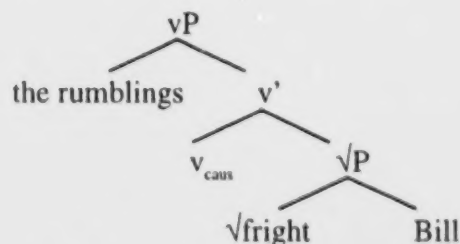
¹⁵ Another causative, *-(s)as*, can also be used in such contexts. This causative has a slightly different interpretation from *-(s)ase*.

In the next section, I argue that not just causative *v*, but *any* category head, will prevent the insertion of idiosyncratic causative morphology in Japanese. Apparently, certain morphological items (or classes of items) are restricted to the local domain of the lexical root. Our account of the T/SM restriction will depend in part on this observation.

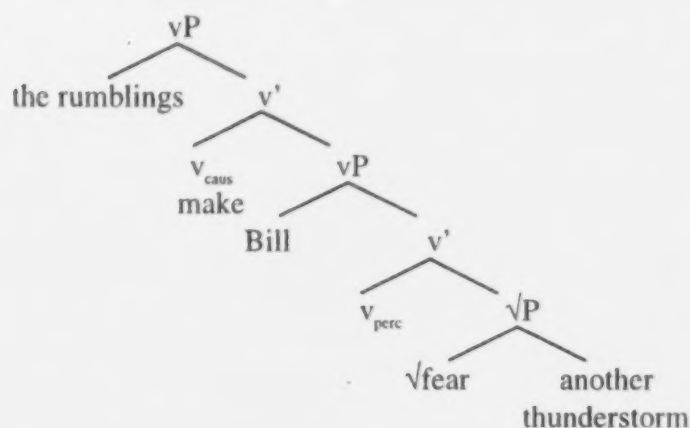
5 The Internal Structure of Psych-Predicates

Before tackling the T/SM restriction, let us begin with a clear notion of the syntax of a PsyCaus verb. Suppose the structure is as in (46a), with the root taking an argument (the Experiencer) and merging with the stative causative *v*. We can compare this with the structure for a category-external causative added to a psychological predicate, as shown in (46b). Here the root merges with noncausative stative *v*, yielding a SubjExp verb whose T/SM argument checks structural Case (here, covertly) on *v*. In English and Italian, this Case is realized by accusative case morphology, in Finnish by partitive case morphology. The SubjExp structure then merges with a causative stative *v* realized as *make*. Finally, consider a category-external psychological causative, in which the SubjExp component is an adjectival predicate rather than a verbal one (47). Here I will assume that the root combines with an adjectival stative event head *a*, again yielding a SubjExp predicate. The adjectival event head does not check structural Case, so if the predicate has a T/SM argument, this argument must be Case-marked by a preposition (here, *of*).

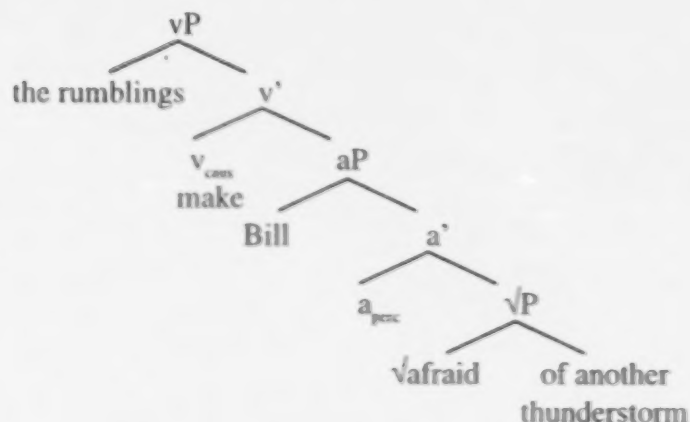
(46)a. The rumblings frightened Bill.



- b. The rumblings made Bill fear another thunderstorm



- (47) The rumblings made Bill afraid of another thunderstorm.



Suppose that the T/SM argument can occur only in the presence of a stative, noncausative event head. Derived nominalizations provide evidence for this claim. In the English derived nominalization of a psych-root, the T/SM argument can only appear as a postnominal PP, not as a prenominal possessor (cf. Pesetsky 1995). For example, a Subject Matter PP is fine in (48a), but as a possessor it is out (48b).¹⁶ (48c) has a reading where Bela Lugosi is the Experiencer of fear, but not one where he is just the Subject

¹⁶Thanks to Alec Marantz for suggesting this argument, as well as for pointing out that the ill-formedness of examples like (47b) could also be attributed to the fact that the T/SM argument is not an "affected" entity (see Anderson 1983).

Matter of fear experienced by someone else. Similarly, in (49a), a Target PP is fine, but the possessive DP cannot be interpreted as a Target. In (49b), a reading is possible in which *anger* characterizes the contents of the article, meaning something like "the article's ferocity", but not where the article is simply the Target of anger. In (49c), Bill can be the Experiencer of anger, but not just the Target of anger experienced by someone else.

- (48) a. Bill's fear of thunderstorms / of Bela Lugosi
 - b. * thunderstorms' fear
 - c. Bela Lugosi's fear
- (49) a. Hillary's anger at the article / at Bill
 - b. ? the article's anger
 - c. Bill's anger

Marantz (1997) argues that the semantic role of the possessor of a derived nominalization must be semantically recoverable from the lexical root. As we saw, an argument of the root can be a possessor. The possessor in (50a) corresponds to the object of the transitive verb *destroy*, while the possessor in (50b) corresponds to the subject of unaccusative *grow*, or the object of transitive *grow*.

- (50) a. the city's destruction
- b. tomatoes' growth

Suppose that arguments of the root are always semantically recoverable from the root (although other arguments may also be recoverable, such as the causative argument in *the army's destruction of the city*). If so, then the T/SM argument is not an argument of the psych-root. Rather, it can only be semantically licensed by certain functional heads, including noncausative stative heads forming nouns, adjectives and verbs. This view is in keeping with Pykkänen's (1998) proposal that an event head can have the semantics of a light perception verb, which takes two arguments, the Experiencer and the Percept (here, the T/SM argument).¹⁷ Let us suppose that this functional "perception" predicate can be verbal or adjectival, permitting two arguments in both verbal and adjectival SubjExp predicates. I assume that a T/SM ar-

¹⁷Pykkänen actually argues that it is the causative event head used with *PsyCaus* verbs that has the semantics of a light perception verb, not the event head used with *SubjExp* verbs.

gument in a derived nominalization is also licensed by a functional head, the nominalizing head (*n*).

Note that in the usual case, we have assumed that a head assigns a theta-role to its sister or its specifier. In the structures given above, however, the event head assigns its T/SM role downwards, to the sister of the root. I adopt this structure because the T/SM argument can apparently check structural Case on a verbal event head (e.g., in (46b)), just as in a regular transitive. Assuming structural Case-checking always involves a relation between an NP and a higher functional head, the event head is above the T/SM argument. Moreover, the verb-T/SM word order in English SubjExp predicates suggests that the T/SM argument is below the event head, since although a root may raise overtly to *v* in English, it generally does not raise to a higher functional head (such as T).¹⁸

Let us review the key claims. The T/SM argument is not an argument of the root. It must be licensed by particular event heads, which generally have the semantics of a light perception verb. Suppose, then, that a causative event head does not itself have the relevant semantics to license a T/SM argument. If so, then the only way to combine the causative meaning with a T/SM argument is to generate a category-external causative, with a lower perception event head in addition to the higher causative event head (see Section 5.1). However, the idiosyncratic causative morphology specified by the root is not used to spell out a category-external causative *v*. In English, the root can specify affixal (or null) morphology only for a root-external causative *v*; category-external causatives must be periphrastic, using the default causative morphology *make*.

5.1 Evidence for a SubjExp Event Head

Thus far we have mainly been concerned with PsyCaus predicates. What is the evidence that SubjExp predicates contain an event head? SubjExp predicates are more like eventive transitive predicates than like PsyCaus predicates, in that they fail to show the classic psych-effects. The similarity is somewhat puzzling, since eventive transitive and SubjExp predicates differ with respect to both causativity and eventivity. However, the two are not syntactically identical. Although—in some languages—SubjExp verbs have a

¹⁸Another alternative would be to say that the T/SM argument is licensed, not by the category-determining event head, but by a separate functional head sandwiched between this head and the root. For example, Alexiadou (1999) suggests that an aspectual functional head (Asp) occurs in this position.

nominative subject and passivize, just like eventive transitives, in others (e.g., Georgian, Icelandic), SubjExp verbs have a "quirky" dative subject, and resist passivization. Arad (1999) proposes that the experiencer subject, and the verb is introduced by a third type of *v*, a stative noncausative *v* (see Marantz 1989 for a similar suggestion). I will adopt this proposal here, leaving open the question of why SubjExp predicates and transitives often appear in the same pattern together, and against PsyCaus predicates.

Is it accurate to call the head that introduces the Experiencer of a SubjExp verb an *event* head? It was reported above (see example (11b)) that Finnish *melkein* 'almost' has only one scope with SubjExp verbs. This suggests that a SubjExp clause contains only one eventuality, namely the one denoted by the lexical root. On closer examination, however, adverbial scope options appear to admit the possibility of a bi-eventive structure for SubjExp predicates. Consider the English examples in (51). (51a) could describe a situation in which *Mimi* was undecided about *Bob*, and was on the point of liking him, but then he did something ghastly that destroyed her opinion of liking him. Alternatively, it could describe a situation in which *Mimi* was quite decided about *Bob*, and what she experienced towards him was a few days approaching affection. A similar ambiguity seems to arise in (51b), where the SubjExp predicate is adjectival.

- (51) a. *Mimi almost liked Bob.*
 b. *Mimi was almost angry with Bob.*

This ambiguity supports the presence of an event head in SubjExp predicates. Let us suppose that the first reading involves modification of the "experience" eventuality denoted by the stative noncausative event *v*, while the second involves modification of the "state of mind" eventuality denoted by the root.¹⁹

However, even if SubjExp predicates include two syntactic heads, this does not necessarily mean that they contain an *event* head. Marantz (1993) argues that the higher indirect object of a double-object verb predicate is generated in the specifier of a light applicative verb. This verb is realized by overt morphology in various Bantu languages, among others. Nevertheless, assuming an applicative verb is present in English, it does not require the default causative morphology *make*. (52) shows double-object predicates with either a causative affix *-en* or no overt causative. Little object predicates have or no overt ap-

¹⁹Of course, this approach predicts that, on closer examination, both adverbial scopes will turn out to be available in Finnish as well.

plicative morphology occurs in English; the applicative head is shown as italicized $\emptyset$ below.

- (52) a. He [_{vp} **thick**- $\emptyset$ -en-ed [_{AppIP} me *t* [_{vp} *t* some soup]]].
 b. John [_{vp} **bake**- $\emptyset$ - $\emptyset$ -ed [_{AppIP} Bill *t* [_{vp} *t* a cake]]].
 c. Mary [_{vp} **kick**- $\emptyset$ - $\emptyset$ -ed [_{AppIP} Sue *t* [_{vp} *t* the ball]]].

Thus, by our assumptions, there are light verbs (such as APPL) that are not event heads. However, there is evidence that, by contrast with APPL, the light verb introducing the Experiencer of a SubjExp predicate is an event head, introducing an "external" argument.

Georgian provides some evidence for a difference between APPL and the SubjExp event head v_{perc} . In Georgian, both the indirect object introduced by APPL and the Experiencer subject introduced by v_{perc} have dative morphological case (Harris 1981). Moreover, many SubjExp verbs have an affix that is morphologically identical to APPL (the "relative prefix" that adds an indirect object to a transitive or unaccusative clause). Nevertheless, the Experiencer subject behaves differently from the indirect object in several ways. For example, some speakers require the reflexive anaphor *tavis tav* to be bound by a subject. These speakers do not permit the indirect object to bind the anaphor (53a), but do permit the Experiencer to do so (53b). Moreover, although the dative Experiencer behaves like the syntactic subject, in a passive the indirect object does not become a dative subject.²⁰ Instead it appears with the postposition *-tvis*, while the direct object becomes the subject (53c).

- (53) a. nino paTara gela-stavis tav-s $\emptyset$ -acveneb-s sarKeSi.
 N.-NOM little G.-DAT self-DAT APPL-show-PRES mirror-in
 'Nino, showed little Gela, herself/*himself, in the mirror.'
 b. temur-s tavis tav-i u-qvar-s.
 T.-DAT self-NOM v-love-PRES
 'Temur loves himself.'
 c. vaSi-i micemulia masCavleblis-tvis.
 apple-NOM give.PASS.PRES teacher-for
 'An apple is given to the teacher.' (Harris 1981:103)

²⁰In this it differs from a dative indirect object in Icelandic, which becomes the subject in a passive, just like a dative Experiencer (Zaenen, Maling & Thráinsson 1985).

It is fairly straightforward to argue that SubjExp verbs have an external argument. Such verbs typically show normal transitive behavior, aside from the possibility of quirky dative case on the subject. According to B&R, Italian SubjExp verbs pattern with transitives, as opposed to verbs with no external argument. For example, as noted above, SubjExp verbs can passivize in many languages (54). Passivization is generally considered possible only for verbs with an external argument.

- (54) a. Mary was loved by all. ENGLISH
 b. Maija-a inho-taan. FINNISH (Pylkkänen 1998)
 M.-PAR find.disgusting-PASS
 'Maija is found disgusting.'
 c. Gianni è/viene temuto da tutti. ITALIAN (B&R)
 G. is/comes feared by everyone
 'Gianni is feared by everyone.'

It is more difficult to demonstrate that adjectival SubjExp predicates have an event head and a corresponding external argument. However, evidence for this view can be found from a contrast noted by Burzio (1986) and Cinque (1990). These authors point out that adjectival predicates typically pattern with unergative verbs, although semantically similar stative verbs are unaccusative. For example, the partitive clitic *ne* 'of them' cannot be extracted from the subject of the adjectival predicate in (55a); *ne*-cliticization is likewise blocked with unergative verbs. By contrast, the stative verbal predicate in (55b) is unaccusative, and allows *ne*-cliticization.²¹

- (55) a. *Ne sarebbero sconosciute_A molte (di vittime).
 of-them would be unknown many (of victims)
 b. Ne sarebbero riconosciute_v molte (di vittime).
 of-them would be recognized many (of victims)

Not all adjectival predicates have external arguments—for example, the subject of English *likely* can be raised from a lower clause (as in *Mary is likely to win*). However, SubjExp adjectives in Italian also block *ne*-cliticization (56). Thus, adjectival SubjExp predicates appear to have an external argument. We can suppose that this argument is introduced by a category-

²¹These examples are quoted from the literature; some of the Italian speakers I have checked them with find them quite marginal.

determining event head, *a*, just as the external argument of a verb is introduced by a category-determining event head, *v*.

- (56) a. * *Ne sarebbero arrabbiate_A molte (di vittime).*
 of-them would be angry many (of victims)
 b. * *Ne sarebbero impaurite_A molte (di vittime).*
 of-them would be afraid many (of victims) (Michela Ippolito, p.c.)

The reasoning here is as follows: given that SubjExp adjectives and verbs are complex predicates, and given that the Experiencer argument is an external argument, we can conclude that the functional head that introduces the Experiencer is an event head, just as in a regular transitive. If a causative is added to a predicate with this event head, it will of course be category-external. In English, such a causative must use the default morphology *make*; the null or affixal causative morphology of a PsyCaus verb cannot be used in forming a causative of a SubjExp predicate. This, I submit, is the right explanation of the T/SM restriction.

5.2 Further Predictions

If it is true that the T/SM restriction follows in part from the morphological properties of English causatives, we can derive a couple of predictions. First, we have suggested that null or affixal causative morphology in English is always root-external, and that adjectival predicates (often) have an external argument introduced by a category-forming event head, *a*. If so, then affixal causatives should usually not attach outside adjective-forming affixes. Secondly, we noted that both root-external and category-external causatives are affixal in Japanese. We expect the T/SM restriction to hold for root-external affixal causatives in Japanese, but not for category-external affixal causatives.

The first prediction holds up fairly well. The causative affixes *-ify* and *-en* are often said to attach to adjectives to form verbs, but these affixes do not attach to stems that already have an adjectival affix. For example, a search of Webster's online dictionary reveals that *-ify* often attaches to bound stems (57a), sometimes to stems that can appear in unaffixed form as adjectives (or nouns) (57b), but never to "derived" adjectives. Causative *-en* does

not appear to attach to bound stems, but it attaches only to stems lacking a suffix (58).²²

- (57) a. beaut-, fort-, dign-, myst-, Russ-, spec-, transmogr- ...
- b. dense, false, diverse, french, just, prett(y), pure, rare, simple, solemn, solid, tack(y), ugl(y)
- (58) awake, broad, coarse, deaf, fresh, glad, hard, loose, mad, neat, quiet, red, sad, thick, weak...

However, there are causative suffixes in English that attach outside adjective-forming suffixes, contrary to the most straightforward prediction. For example, English *-ize* attaches to derived adjectival forms of various kinds (59).²³ Nevertheless, unlike periphrastic *make*, which can also be added outside an adjectival predicate, *-ize* does not allow both a Causer and a T/SM argument (60c).

- (59) a. *-ic*: metr-ic, myth-ic, poet-ic...
- b. *-(u)al*: centr-al, palat-al, trib-al, concept-ual, sex-ual, intellect-ual...
- c. *-ar*: pol-ar, line-ar, singul-ar...
- d. *-(ia)n*: America-n, India-n, Russ-ian, grec-ian, ital-ian...
- e. *-ive*: collect-ive, subject-ive, relat-ive...
- (60) a. The citizens were terrified of the dictator.
- b. The soldiers terrorized the citizens.
- c. * The soldiers terrorized the citizens of the dictator.

Although, like causative *make*, *-ize* can attach outside some category-determining morphology, it is subject to a special restriction. Note that, unlike *make*, *-ize* never attaches outside a causative head, such as the head that introduces the agent *Heidi* in (61). It can form a root-external causative (61a), but not a causative of a causative (61b).

- (61) a. The advice of the pet store made [Heidi gradually acclimate/acclimatize her cats to the weather in Arizona].

²²I assume that *humid* and *rigid* are in fact underived, despite the existence of the apparently related words *humor* and *rigor*. I also assume that the verbs *bedizen*, *beto-ken*, *cozen*, and *open* are not analyzed by English speakers as bound roots suffixed with *-en*.

²³*-al* and *-ar* may well be phonologically conditioned allomorphs of the same morpheme (Morris Halle, p.c.).

- b. * The advice of the pet store acclimatized [Heidi gradually (of) her cats to the weather in Arizona].

Observing that *-ize* can only attach to Latinate roots or affixes, Pesetsky (1995) proposes that *-ize* cannot attach to a causative because *CAUS* (here, v_{caus}) in English is [-Latinate]. We can make the same proposal here for a_{perc} . The adjective-forming affixes in (59) are [+Latinate], but if a_{perc} is [-Latinate] in English, *-ize* will not attach to it; a category-external causative v will instead be spelled out with non-affixal causative morphology, like *make*.

Note also that although *-ize* and *make* are both category-external, they may not spell out exactly the same syntactic/semantic features. Lieber (1998) argues that *-ize* is not generic causative morphology, but rather spells out a distinct core meaning, which she calls ACT. Although adding a causative to a predicate containing a_{perc} produces a semantically and syntactically well-formed structure, it does not follow that adding ACT does.

In general, then, the evidence seems to support our first prediction, namely that causative affixes in English will not attach outside of adjective-forming affixes. Because *-ize* attaches outside adjective-forming affixes, we might expect it to be able to attach outside a_{perc} , like *make*. However, the fact that *-ize* cannot attach outside a_{perc} , can be attributed to morphological and perhaps semantic restrictions on its distribution. Thus the account given successfully predicts that *make*, and not affixal causatives, can be used to add a causative meaning to a predicate with a Causer and a T/SM argument in English.

We now turn to the second prediction, that Japanese root-external causatives will display the T/SM restriction, while category-external causatives will not. This prediction is also borne out. Miyagawa (1980) notes a semantic contrast between two causative counterparts of the SubjExp predicate *odoroku* 'be surprised'. The causative formed with *-(s)as*, in (62a), has the interpretation of a PsyCaus verb, with the Causer directly producing surprise in the Experiencer. The causative formed with *-(s)ase*, as in (62b), has a category-external causative interpretation, with the Causer indirectly producing surprise in the Experiencer. For example, in (62a) the actress's surprise is a genuine response to the director, while in (62b) it could simply be produced for effect, in response to a direction.

- (62) a. Eiga kantoku-ga zyoyuu-o odorok-asi-ta.
 movie director-NOM actress-ACC surprise-CAUS-PAST
 'The movie director surprised the actress.'

- b. Eiga kantoku-ga zyoyuu-o odorok-ase-ta.
 movie director-NOM actress-ACC surprise-CAUS-PAST
 'The movie director made the actress be surprised.'

In the noncausative SubjExp counterpart, a T/SM argument with dative *ni* can be introduced (63a). However, this argument can only be used with the category-external *-(s)ase* causative (63b), not with the root-external *-(s)as* causative (63c) (Kazuaki Maeda, p.c.). As predicted, the T/SM restriction holds in a root-external causative, but not in a category-external causative.

- (63) a. Zyoyuu-ga sono koto-ni odoroi-ta.
 actress-NOM that fact-DAT surprise-PAST
 'The actress was surprised at that fact.'
 b. Eiga kantoku-ga zyoyuu-o sono koto-ni odorok-ase-ta.
 movie director-NOM actress-ACC that fact-DAT surprise-CAUS-PAST
 'The movie director made the actress surprised at that fact.'
 c. * Eiga kantoku-ga zyoyuu-o sono koto-ni odorok-asi-ta.
 movie director-NOM actress-ACC that fact-DAT surprise-CAUS-PAST
 'The movie director surprised the actress at that fact.'

(63c) is apparently well-formed semantically, given that both types of causative allow an additional "causer" argument to be introduced by the particle *de*:

- (64) a. Eiga kantoku-ga zyoyuu-o sono koto-de odorok-ase-ta.
 movie director-NOM actress-ACC that fact-b/c surprise-CAUS-PAST
 'The movie director made the actress surprised because of that fact.'
 b. Eiga kantoku-ga zyoyuu-o sono koto-de odorok-asi-ta.
 movie director-NOM actress-ACC that fact-b/c surprise-CAUS-PAST
 'The movie director surprised the actress because of that fact.'

The behaviour of Japanese causatives supports our second prediction: the T/SM restriction holds only in a root-external causative, even if the category-external causative is also affixal.

6 Conclusions

I have argued here that the T/SM restriction arises from two causes. First, the Target or Subject Matter argument is licensed, not of the root, but by the noncausative stative event head occurring in SubjExp predicates, which de-

termines the category of the predicate, and conveys the semantics of perception (v_{perc} or a_{perc}). Thus, a T/SM argument can arise only in the presence of such a head. Secondly, adding a Causer to a predicate with a category-determining head generally blocks the use of null or affixal causative morphology in English, so only a periphrastic causative can be used when both the Causer and T/SM arguments are present. PsyCaus verbs are root-external causatives, involving only one event head (the causative v), so English allows null or affixal causative morphology here. In Japanese, however, a category-external causative can also use affixal morphology. There the T/SM restriction arises only with root-external affixal causatives, and not with category-external affixal causatives.

The approach sketched here makes it possible to preserve the view that A-movement respects locality; as such, it is worth pursuing further.

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Echo Reduplication in Kannada: Implications for a Theory of Word Formation*

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1 Introduction

According to the Lexicalist Hypothesis, morphological structure is built in the lexicon by processes distinct from those that build syntactic structure. The structure of morphologically complex words is erased upon insertion into a syntactic phrase-marker and hence, is invisible to sentence-level operations and descriptions (Chomsky 1981, DiScullo and Williams 1987, Kiparsky 1982, Mohanan 1981). Hand in hand with this morphosyntactic hypothesis are the following morphosemantic and morphophonological claims. First, some structure-meaning correspondences are created in the lexicon and hence are idiosyncratic, as in (1a, b), while others are created in the syntax and hence are transparently compositional, as in (1c):

- (1) a. /kæt/ = CAT
b. /trans+mit+ion/ = PART OF A CAR
c. a cat sleeps = SLEEP(CAT)

Second, some phonological rules apply in the lexicon, and hence can have idiosyncratic properties (e.g., English trisyllabic laxing: (2a) vs. (2b)), while others apply postsyntactically (or everywhere) and hence are exceptionless (e.g., English flapping: (3a) vs. (3b)).

- (2) a. ser[ij]n : ser[ɛ]nity
b. ob[ij]s : ob[ij]sity
- (3) a. sea[D]ed
b. Have a sea[D]. I'll be right back.

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A corollary of the lexicalist hypothesis is that there should be converging criteria which distinguish words from constituents of larger size. We expect various measures of wordhood to lead us to the same object. The domain of semantic idiosyncrasy should be the same as the domain of phonological idiosyncrasy. Recent work in the framework of Distributed Morphology challenges lexicalism by showing that there is no single object that is defined by these various criteria (Marantz 1997, Noyer 1998). The elements with idiosyncratic meaning are not the same as the elements defined phonologically as words. Neither of these, in turn, correlates with the domain of non-productive morphological rules. Hence, these authors conclude that there is no well-defined category of word, and so a lexicalist grammatical architecture in which idiosyncratic semantic, syntactic and phonological properties are stored together in a single lexicon becomes less plausible.

This paper adds to the arguments against lexicalism by focusing on the syntactic properties of a morphological rule in Kannada traditionally referred to by Dravidianists as *Echo Reduplication* (Emenau 1938).¹ I will show that *Echo Reduplication* (ER) in Kannada applies equally to words, subparts of words and entire syntactic phrases.² Because ER can apply to phrasal categories, we must conclude that it applies post-syntactically; it takes syntactic structures as input and returns morphological forms. Given that it also applies to morphological units which form subparts of words, we conclude that these units are also visible post-syntactically. That is, the internal, sub-word, structure must be visible at the same point as the phrasal structure. Hence, a theory in which word-internal structure is erased prior to the construction of phrases becomes more difficult to maintain. The alternative to the lexicalist theory is one in which syntax provides the input to the morphological component, as in the Distributed Morphology framework. On this view all structure composition takes place in the syntax, which in turn is read by the morphological module.

It is important to observe, however, that there are morphological structures which do not allow ER to apply inside of them, suggesting that some morphological structure is not phrase-structurally represented. Hence, we have evidence that some amount of morphological structure can be seen as

¹This kind of rule is usually called "fixed melody reduplication" in the generative phonological tradition. See, for example, McCarthy 1982, Marantz 1982, Yip 1992, Jha, Sadanand and Vijayakrishnan 1997 for morphophonological analysis.

²Unless noted otherwise, all Kannada data were collected in 1998 and 1999 from R. Amritavalli, S. Chandrashekar and S. Vedantam. Special thanks to R. Amritavalli for her time and careful assistance in the construction of these data.

syntactic structure and that some amount of morphological structure cannot. If the morphological structure that is not phrase-structural were to correspond to some other criteria of lexical item, then we would be able to maintain the lexicalist hypothesis. It does not, however. This leaves us with the question of how to distinguish those pieces of morphological structure that allow ER to apply inside of them from those that do not in a theory without a traditional lexicon, such as Distributed Morphology. I propose that the relevant distinction is between apparent 'morphemes' which are added to the root inside a postsyntactic morphological component and those which are added to the root by syntactic composition.

The paper proceeds as follows. In section 2, I will introduce ER, describing the environments in which it can apply and the problems that these data pose for various versions of the lexicalist hypothesis. In section 3, I present some other possible analyses of ER that maintain the lexicalist hypothesis and I show why these fail to account for the data adequately. In section 4, I present an additional argument from affix ordering against a lexicalist analysis of ER. Finally, in section 5, I outline an analysis of the apparent exceptions to the rule of ER.

2 The Facts

ER in Kannada repeats an element, replacing the first CV with *gi-* or *gi:-* (depending on the length of the input vowel), and yields a meaning of 'and related stuff' (reduplicant glossed as RED):¹

- | | | | |
|--------|---------|----|---------------------------|
| (4) a. | pustaka | b. | pustaka-gistaka |
| | book | | book- RED |
| | 'book' | | 'books and related stuff' |

¹Although this paper is not concerned with giving a phonological analysis of ER, phonologically minded readers will want to know what happens when a word beginning with *gi-* undergoes ER. Four informants gave four different answers to this question. One speaker said that ER applies to such words just as it would to any other word. Hence, we find: *giDa* 'plant' → *giDa-giDa*. A second speaker said that the first consonant of the reduplicant must change to either *b* or *v*: *giDa-biDa*, or *giDa-viDa*. The third speaker agreed with both of the other two speakers in allowing either substitution or not and also said that some speakers may simply be unable to reduplicate such a word at all. The fourth speaker requires the fixed melody to be changed to *pa*: *giDa-paDa*. See Jha et al. 1997 for a phonological analysis of ER in various Indian languages. Also see Trivedi 1990 for a typology of ER in India.

ER can apply to all classes of words except interrogative monstrative adjectives (Sridhar 1990). In (4) we see ER apply to pronouns and demonstratives; in (5), a verb; in (6), an adjective; and, in (7) a preposition: applying to a noun;

- | | | | |
|--------|---------------------------|----|---|
| (5) a. | ooda
run
'run' | b. | ooda-giida beeDa
run-RED PROH
'Don't run or do related activities.' |
| (6) a. | doDDa
large
'large' | b. | doDDa-giDDa
large-RED
'large and the like' |
| (7) a. | meele
above
'above' | b. | meele-giile
above-RED
'above and the like' |

ER may apply either inside ((8a), (9a)) or outside ((8b), (9b)) of inflectional elements:⁴

- | | |
|--------|--|
| (8) a. | baagil-annu much-gich-id-e anta heeLa-beeDa
door-ACC close-RED-PST-IS that say-PROH
'Don't say that I closed the door or did related activities.' |
| b. | baagil-annu much-id-e-gichide anta heeLa-beeDa
door-ACC close-PST-IS-RED that say-PROH
'Don't say that I closed the door or did related activities.' |
| (9) a. | baagil-giigil-annu much-id-e
door-RED-ACC close-PST-IS
'I closed the door and related things.' |
| b. | baagil-annu-giigilannu much-id-e
door-ACC-RED close-PST-IS
'I closed the door and related things.' |

Entire phrasal categories may be reduplicated by ER:

⁴K.G. Vijayakrishnan (personal communication) reports that related Dravidian language, does not allow ER to apply inside cat Tamil, a closely related language of inflectional elements.

- (10) a. nannu baagil-annu much-id-e giigilannu muchide
 I-NOM door-ACC close-PST-1S RED
 anta heeLa-beeDa
 that say-PROH
 'Don't say that I closed the door or did related activities.'
- b. pustav-annu meejin-a meele giijina meele nooD-id-e
 book-ACC table-gen on RED see-PST-1S
 'I saw the book on the table and in related places.'

The data in (8–10) are problematic for the strictest variant of the lexicalist hypothesis, namely one in which all morphological composition takes place in the lexicon. To my knowledge, no-one has ever explicitly held such a position (but see Chomsky 1993, which may hold it implicitly). The reason such data are problematic for the staunch lexicalist is that the rule applies equally to subword and phrasal constituents, an impossibility if the internal morphological structure is erased upon insertion into the syntactic phrase-marker.

2.1 Variants of Weak Lexicalism

2.1.1 Derivation = Lexical. Inflection = Syntactic

One step back from the staunch lexicalist is the weak-lexicalist, who would hold that derivation and inflection are distinguished with respect to the lexicon. On this view, derivational morphology applies inside the lexicon while inflectional morphology applies outside the lexicon (Anderson 1984, 1992). The weak lexicalist would expect a syntactic rule of ER to be able to capture the facts given in (8–10), but would predict that ER would not be able to reach into complex words formed by rules of derivational morphology.

In (11–13) we see that ER can apply either inside or outside of valency changing morphology, prototypically considered to be derivational/lexical (Grimshaw 1982, Lieber 1980, Selkirk 1982, DiSciullo and Williams 1987):⁵

⁵See Lidz (1998) for arguments that the reflexive and causative morphology of Kannada is not added to a root inside the lexicon.

(11) Anticausative use of reflexive

- a. muchu
close
'to close (tr.)'
- b. muchi-koLLu
close-REFL
'to close (intr.)'
- c. baagilu muchi-gichi-koND-itu anta heeLa-beeDa
door-NOM close-RED-REFL.PST-3SN that say-PROH
'Don't say that the door closed or did related things.'
- d. baagilu muchi-koND-itu-gichikoNDitu anta heeLa-beeDa
door-NOM close-REFL.PST-3SN-RED that say-PROH
'Don't say that the door closed or did related things.'

(12) Reflexive use of reflexive

- a. hogaLu
praise
'to praise'
- b. hogaLi-koLLu
praise-REFL
'to praise oneself.'
- c. rashmi tann-annu hogaLi-gigaLi-koND-aLu anta heeLa-beeDa
Rashmi self-ACC praise-RED-REFL.PST-3SF that say-PROH
'Don't say that Rashmi praised herself and did related activities.'
- d. rashmi tannannu hogaLi-koND-aLu-gigaLikoNDaLu
Rashmi self-ACC praise-REFL.PST-3SF-RED
anta heeLa-beeDa
that say-PROH
'Don't say that Rashmi praised herself and did related activities.'

(13) Causative

- a. kaTTu
build
'to build'
- b. kaTT-isu
build-CAUS
'to make build'
- c. naanu mane-yannu **kaTT-giTT-is-id-e** anta heeLa-beeDa
I-NOM house-ACC **build-RED-CAUS-PST-IS** that say-proh
'Don't say that I had a house built and did related activities.'
- d. naanu mane-yannu **kaTT-isi-giTTis-id-e** anta
I-NOM house-ACC **build-CAUS-RED-PST-IS** that
heeLa-beeDa
say-PROH
'Don't say that I had a house built and did related activities.'
- e. naanu mane-yannu **kaTT-is-id-e-giTTiside** anta
I-NOM house-ACC **build-CAUS-PST-IS-RED** that
heeLa-beeDa
say-PROH
'Don't say that I had a house built and did related activities.'

Similarly, ER can occur inside or outside of category changing morphology, such as the verbalizing use of the causative morpheme or the deadjectivalizing pronominal affixes.

(14) Verbalizing use of causative

- a. patra
letter
'letter'
- b. patr-isu
letter-CAUS
'to write a letter'

- c. Rashmi Vijay-ige **patra-gitr-is-id-aLu** anta heeLa-beeDa
 Rashmi Vijay-DAT **letter-RED-CAUS-PST-3SF** that say-PROH
 'Don't say that Rashmi wrote Vijay a letter and did related activities.'
- d. Rashmi Vijay-ige **patr-is-gitris-id-aLu** anta heeLa-beeDa
 Rashmi Vijay-DAT **letter-CAUS-RED-PST-3SF** that say-PROH
 'Don't say that Rashmi wrote Vijay a letter and did related activities.'

(15) Deadjectival nouns

- a. cikka
 small
 'small'
- b. cikk-avanu
 small-he
 'one who is small.'
- c. avanu **cikk-gikk-avanu** alla
 he-NOM **small-RED-he** NEG
 'It's not as if he's a young etc. man.'
- d. avan-annu **cikk-avanu-gikkavanu** anta heeLa-beeDa
 he-ACC **small-he-RED** that say-PROH
 'Don't say that he's a young man and such.'

These data are problematic for the weak-lexicalist because in them, ER treats the substructures of words with derivational morphology as equivalent to the substructures of words with inflectional morphology and entire syntactic phrases. Hence, a view in which derivation is lexical but inflection is syntactic will not divide the world in a way consistent with the demands of ER.

It is important to note at this point that there are some domains in which ER may not apply. Consider the examples in (16-20), in which ER cannot apply inside of certain affixes.

- (16) a. toor-ike
 show-NMNL
 'appearance'

- b. * toor-**giir**-ike
show-red-nmnl
- c. toor-ike **giirike**
show-nmnl **RED**
'appearances and related things'
- (17) a. tooru-vike
show-GER
'showing'
- b. * toor-**giiru**-vike
show-**RED**-GER
- c. tooruvike **giiruvike**
show-ger **RED**
'showing and related activities'
- (18) a. ooD-aaTa
run-play
'running around'
- b. * ooD-**giiD**-aaTa
run-**RED**-play
- c. ooD-aaTa **giiDaaTa**
run-play **RED**
'running around and related activities'
- (19) a. hoogu-vudu
go-GER
'going'
- b. * hoog-**giig**-uvudu
go-**RED**-GER
- c. hoogu-vudu **giiguvudu**
go-GER **RED**
'going and related activities'

- (20) a. doDDa-tana
 large-NOM
 'largeness'
- b. * doDD-**giDDa**-tana
 large-RED-nom
- c. doDDatana **giDDatana**
 large-NOM RED

The fact that ER cannot apply inside of certain derivational affixes suggests that weak lexicalism may be right in saying that some morphological operations are syntactically represented while others are not, but wrong in making the division correspond to the division between derivation and inflection (perhaps suggesting that such a distinction is not real). We return to this question below.

2.1.2 Idiosyncratic = Lexical. Compositional = Syntactic

An alternative variant of weak lexicalism might say that the distinction between lexicon and syntax is not reflected in the difference between derivation and inflection, but rather in the difference between the idiosyncratic and the compositional. On this view, we might expect ER to be able to reach only inside of semantically compositional structures, but not inside of noncompositional structures. This hypothesis is immediately called into question by the fact that ER can apply to the internal elements of idiomatic expressions, as demonstrated in (21) and (22).

- (21) a. Hari kannu much-id-a
 Hari eye close-PST-3SM
 'Hari died.' (lit. Hari closed his eyes)
- b. Hari **kannu-ginnu** much-id-a
- c. Hari kannu muchida ginnu muchida
- (22) a. Rashmi Hari-ge maNNu tinn-is-id-aLu
 Rashmi Hari-DAT mud eat-CAUS-PST-3SF
 'Rashmi ruined Hari.' (lit. Rashmi made Hari eat mud)
- b. Rashmi Hari-ge **maNNu giNNu** tinn-is-id-aLu

c. Rashmi Hari-ge maNnu tinn-is-id-aLu giNnu tinnisidaLu

The existence of phrasal idioms like (21a) and (22a) is potentially problematic for the lexicalist hypothesis by themselves because they show that the domain of semantic idiosyncrasy does not correspond to the morphophonological word. While this problem does not seem to alarm lexicalists (cf. Jackendoff 1997), the fact that ER treats the subparts of syntactic idioms on a par with the subparts of syntactic phrases may. The fact that ER treats the subparts of semantically non-decomposable chunks on a par with the subparts of semantically decomposable chunks suggests that a grammar which separates the lexicon from the syntax on the basis of semantic idiosyncrasy embodies the wrong architecture.

The problems for a variant of lexicalism that takes idiosyncrasy to be the hallmark of the lexicon can also be seen by examining the distinction between "word-level" and "stem-level" affixation. Aronoff and Sridhar (1983) show that the distinction between word-level and stem-level affixation in Kannada is diagnosed by a correspondence between epenthetic [u] (Bright 1972) and semantic transparency. They demonstrate the correlation by examining the properties of the nominalizing suffix *-ike*. When attached at the stem-level, there is no epenthetic [u] and the meaning of the derived form is idiosyncratically related to the base. On the other hand, when this affix is attached at the word-level, there is an epenthetic [u] and the derived form is transparently a gerund. Moreover, there are some verbs for which there is no stem-level variant, whereas all verbs have a word-level, gerundive variant.

(23)	verb	gloss	+ike	gloss	#ike	gloss
a.	beeDu	'beg'	beeDike	'plea'	beeDuvike	'begging'
b.	jaaru	'slide'	jaarike	'slipperiness'	jaaruvike	'sliding'
c.	keeLu	'ask'	kaaLike	'request'	kaaLuvike	'asking'
d.	tooru	'show'	toorike	'appearance'	tooruvike	'showing'
e.	horaDu	'leave'	*hooraDike		horaduvike	'leaving'

Now, if we take a variant of the lexicalist hypothesis to hold that productive morphological rules with transparent meaning are syntactic while nonproductive morphological rules with idiosyncratic meaning are lexical, then we would expect to find ER able to apply inside of gerundive *-ike* but not inside of the stem-level variant of this affix.

The data come out otherwise. ER is not possible inside of either variant of *-ike*, a problem to which we will return.

- (24) a. toor-ike
show-NMNL
'appearance'
- b. * toor-**giir**-ike
- c. toorike **giirike**
- (25) a. tooru-vike
show-GER
'showing'
- b. * tooru-**giiru**-vike
- c. tooruvike **giiruvike**

Even worse for this variant of lexicalism is that there are both stem-level and word-level affixes that ER can apply inside of, such as the causative *-isu* and the plural *-gaLu*, respectively:

- (26) a. beeD-isu
beg-CAUS
'to cause to beg'
- b. * beeDu-visu
- c. beeD-**giiD**-isu
beg-**RED**-CAUS
'to cause to beg and related activities'
- d. beeD-isu-**giiDisu**
beg-CAUS-**RED**
'to cause to beg and do related activities'
- (27) a. kaalu-gaLu
leg-PL
'legs'
- b. * kaaligaLu

- c. kaalu-**giilu**-gaLu
leg-RED-PL
'legs and stuff'
- d. kaalu-gaLu-**giilugaLu**
leg-PL-RED
'legs and stuff'

We can conclude that neither the distinction between stem-level and word-level affixation, nor the related distinction between semantically idiosyncratic and semantically transparent affixation gives us a way to determine which affixes ER can apply inside of and which it cannot.

3 Some Less Plausible Lexicalist Solutions

3.1 Two Rules

One possibility for maintaining lexicalism given that ER applies equally to subparts of words and entire phrases would be to posit two rules of ER. On this view, there are two separate but identical rules of reduplication, one applying in the lexicon (to sublexical material) and a second applying in the syntax (to lexical and phrasal material).

The problem with the two rules gambit is that it is redundant. Giving up the Lexicalist Hypothesis in favor of a theory in which morphologically complex words are syntactically complex allows us to explain ER with one rule which applies to any syntactic constituent.

3.2 ER is Phonological

A second possibility for maintaining the Lexicalist Hypothesis would be to say that ER is phonological. A phonological analysis of ER, in which the elements which can undergo reduplication are all of the same phonological category, would circumvent the lexicalist objection by showing that the rule has no morphosyntactic relevance.

This tack is problematic for three reasons. First, there is no single phonological constituent represented by the elements which can undergo ER. That is to say, given a single input like (28a), the rule produces three outputs:

- (28) a. kaTT-is-id-e
build-CAUS-PST-1S
- b. kaTT-**giTT**-is-id-e
build-**RED**-CAUS-PST-1S
- c. kaTT-isi-**giTTis**-id-e
build-CAUS-**RED**-PST-1S
- d. kaTT-is-id-e-**giTTiside**
build-CAUS-PST-1S-**RED**

ER can apparently decide to break the word at its any of its morpheme boundaries, irrespective of phonological constituency. This point is especially clear, when we examine a word whose morphological structure differs from its phonological structure. Consider (29), with the morphological structure in (29b) and the syllabification in (29c):

- (29) a. hogaLikoNDaLu
'she praised herself.'
- b. [[[hogaLi]-koND] -aLu]
praise -REFL.PST-3SF
- c. ho.ga.Li.koN.Da.Lu

The three possible outputs of ER given (29a) are those in (30).

- (30) a. hogaLi-**gigaLi**-koND-aLu
- b. hogaLi-koND-**gigaLikoND**-aLu
- c. hogaLi-koND-aLu-**gigaLikoNDaLu**

These correspond to the morphological constituents of (29). Impossible ERs of (29a) are given in (31).

- (31) a. * ho-**gi**-gaLikoNDaLu

- b. * hoga-**giga**-LikoNDaLu
- c. hogaLi-**gigaLi**-koNDaLu (= (30a))
- d. * hogaLikoN-**gigaLikoN**-DaLu
- e. * hogaLikoNDa-**gigaLikoNDa**-Lu

The reduplications in (31) are the outputs of an ER rule applied to (groups of) syllables. For example, (31a) reduplicates just the first syllable, (31b) reduplicates the first two syllables, etc. None of these is a possible reduplication (with the exception of (31c) which corresponds to a morphological break as well as a phonological one), despite the fact that any of them could potentially occur if syllables (or larger prosodic units made up of syllables) were the units over which the rule applied.

A bigger problem for the phonological analysis is that the rule respects morphological and syntactic constituency. In the ungrammatical (32), just the nonroot elements of the verb are reduplicated. These morphemes do not form a morphosyntactic constituent and so this reduplication is barred.

- (32) * hogaLi-koND-aLu-**giNDaLu** (cf. (29b))

In (33c), a hypothesized phrasal reduplication of (33a) (whose structure is (33b)), we see that it is ungrammatical to reduplicate the subject and object to the exclusion of the verb, despite the fact that these elements are adjacent in the string. Only syntactic constituents can be reduplicated.

- (33) a. Rashmi avan-annu hogaL-id-aLu
 Rashmi he-ACC praise-PST-3SF
 'Rashmi praised him.'
- b. [_{NP} Rashmi [_{TP} [_{VP} avan-annu hogaL-] id-] aLu]
- c. * **Rashmi** avan-annu **gishmi-avanannu** hogaL-id-aLu
 Rashmi he-ACC **RED** praise-PST-3SF
 Intended: 'Rashmi and related people praised him and related people.'

An additional problem with the phonological analysis of ER is that ER is syntactically and semantically restricted when it involves a predicate (V or VP). A predicate may undergo ER only if it is embedded under a modal ele-

ment, such as prohibitive (negative imperative (= (34)), negation (= (35a,b)), question-morpheme (= (35b,c)), etc.:

- (34) a. * baagil-annu **much-gich-id-e**
 door-ACC close-RED-PST-1S
 'I closed the door and did related activities.'
- a'. baagil-annu **much-gich-id-e** anta heeLa-beeDa
 door-ACC **close-RED-PST-1S** that say-PROH
 'Don't say that I closed the door and did related activities.'
- b. * baagil-annu **much-id-e gichide**
 door-ACC close-PST-1S RED
 'I closed the door and did related activities.'
- b'. baagil-annu **much-id-e gichide** anta heeLa-beeDa
 door-ACC **close-PST-1S-RED** that say-PROH
 'Don't say that I closed the door and did related activities.'
- c. * naanu **baagil-annu muchide giigilannu muchide**
 I-NOM door-ACC close-PST-1S RED
 'I closed the door and did related activities.'
- c'. naanu **baagil-annu muchide giigilannu muchide**
 I-NOM **door-ACC close-PST-1S RED**
 anta heeLa-beeDa
 that say-PROH
 'Don't say that I closed the door and did related activities.'
- d. **baagil-annu-giigilannu muchide**
door-ACC-RED close-PST-1S
 'I closed the door and related things.'
- (35) a. hari baagilannu **muchi-gich-al-illa**
 Hari door-ACC close-RED-INF-NEG
 'Hari didn't close the door or do any such thing.'
- b. niinu baagil-annu **muchi-gich-al-illa-valla-a**
 you door-ACC close-RED-INF-NEG-TAG-Q
 'You didn't close the door or do any such thing, did you?'

- c. hari baagil-annu **muchhi-gich-id-a-a**
 Hari door-ACC close-RED-PST-3SM-Q
 'Did Hari close the door or do any such thing?'

Given that the same phonological material can be reduplicated successfully in some syntactic/semantic contexts but not in other syntactic/semantic contexts, a strictly phonological analysis is untenable.

4 Level Ordering, ER and the Lexicalist Hypothesis

The distinction between word-level and stem-level affixation gives us an additional argument for morphological structure being syntactically visible. The argument grows out of A&S's observation that word-level affixation can apply inside of stem-level affixation in Kannada.⁶ A&S's discussion is based on two suffixes: the dative *-ge* and the plural *-gaLu*.

First, all forms to which *-gaLu* attaches can occur as free forms whereas the same is not true of forms to which *-ge* attaches.

(36)		<u>singular</u>	<u>plural</u>	<u>dative</u>	
a.	'house'	mane	manegaLu	manege	
b.	'rock'	banDe	banDegaLu	banDege	
c.	'leg'	kaalu	kaalugaLu	kaalige	*kaali
d.	'forest'	kaaDu	kaaDugaLu	kaaDige	*kaaDi

In (36c-d), both the [u] in the singular and plural forms and the [i] in the dative are epenthetic. The [u] is added word finally to all consonant final stems, as can be seen clearly in borrowings of consonant final words:

(37)a.	'spoon'	spuunu
b.	'car'	kaaru
c.	'pen'	pennu
d.	'bus'	bassu

From this A&S conclude that *-gaLu* is a word-level affix because the same epenthetic vowel occurs on stems to which it attaches as on whole words. The [u] of *-gaLu* is this same epenthetic vowel. This can be seen when we add casemarkers to a plural word. In such an environment the

⁶See Aronoff (1976) for the same observation in English.

epenthetic [u] does not occur. Moreover, when we add a consonant initial casemarker it is the epenthetic [ɪ] which occurs.

- (38) a. 'car-PL-ACC' kaaru-gaL-annu
 b. 'car-PL-DAT' kaaru-gaLi-ge

Now, the fact that the stem-level dative (and other casemarkers, as evidenced by the epenthesis facts) occurs outside of the word-level plural leads A&S to conclude that there is no level-ordering in the sense of Mohanan (1981) and Kiparsky (1982). They don't deny that the levels exist but only claim that there is no ordering and no bracket erasure.

A&S's conclusion is lexicalist in nature because it assumes that there are different levels of affixation in the lexicon. There is an alternative analysis, of course, which posits that the difference between the stem-level and word-level affixes is stated not in terms of levels, but in terms of boundary symbols, as in Chomsky and Halle (1968). The important thing of boundary symbols is that there are two kinds of boundaries and that there are no ordering restrictions on these boundaries. They assume that these are types of lexical boundaries, though nothing they say forces this conclusion. The final result is only that the boundaries are visible simultaneously.

Now, given the observation that ER can apply to syntactic phrases as well as to sub-word constituents and the observation that word-level and stem-level boundaries must be visible simultaneously, we are led to the conclusion that these levels are syntactically represented. That is, A&S tell us that the two types of boundaries are marked at the same level, but are agnostic as to whether this is in the lexicon or in the syntax. Given that ER can (a) reach inside of these boundaries and (b) apply to syntactic phrases, we are led to conclude that the two types of boundaries are syntactically, and not lexically, represented.

5 When Echo Does Not Apply

This section provides a first step towards determining whether there is any systematicity in which affixes are syntactically represented. As we have seen, using ER as a test leads us to conclude that certain cases of apparent affixation are not syntactically complex. To account for these facts, a view in which all morphology is postsyntactic, such as Distributed Morphology, will require that some morphological structure is represented phrase-structurally.

and other morphological structure is due to nonstructural aspects of the syntax.

Consider, as an illustration, Marantz's (1997) reinterpretation of Chomsky's (1970) arguments about nominalization. Marantz's hypothesis takes it that the relation between a verb and its nominalization is based on syntactic category only. There is a single root whose pronunciation depends upon its syntactic category. In other words, a nominalization is simply what you get when you put a root of a certain type in the nominal environment; if you were to put this root in a verbal environment, you would have gotten a verb. There is no transformation from one to the other. For example, the root $\sqrt{\text{destr-}}$ in the verb context will be pronounced *destroy* and in the noun context will be pronounced *destruction*. On this view, it is not the case that *-tion* is an affix heading its own piece of phrase structure (or morphological structure). Rather, the environment of the root determines whether it will be pronounced with the *-tion* affix. The simple fact of being dominated by an N node determines whether this affix is present. Here, the syntax determines the pronunciation, but by feature, not by configuration. In other words, under the Marantz-Chomsky hypothesis, the root $\sqrt{\text{destr-}}$ has the following morphological properties:

- (39) a. $\sqrt{\text{destr-}} \leftrightarrow [N \text{ destruction}]$
 b. $\sqrt{\text{destr-}} \leftrightarrow [V \text{ destroy}]$

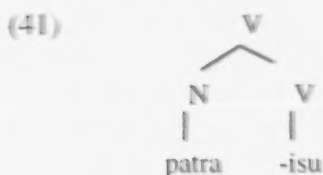
Hence, the factor determining how the root is realized is the syntactic category of the word, not its syntactic structure. In fact, it has no syntactic structure. The 'affixes' which appear on the root arise because of the syntactic environment but are not explicitly represented as nodes in a nested tree-structure.

Other affixes, of course, quite clearly are syntactic heads and the facts of ER give us a way to determine which ones these are (in Kannada). ER can tell us which affixes are present because they correspond to independent heads in the phrase structure and which are present because of categorical properties of the context. In other words, given the conclusion that morphology applies postsyntactically and the fact that some affixes appear to be phrase-structurally represented while others do not, we are led to the conclusion that some apparent affixes occur because of aspects of the syntactic environment which are not part of the nested tree-structures we take to be the core of syntactic combination.

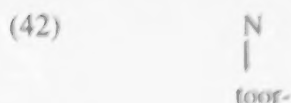
The two kinds of "affixation" are illustrated in (40).

- (40) a. patr-isu
letter-CAUS
'to write a letter'
- b. toor-ike
show-NMNL
'appearance'

Because ER can reach inside of a morphologically complex word like (40a), we take the boundary between the morphemes to be syntactically represented. The root and the affix each head their own pieces of phrase structure, as in (41):



ER cannot apply inside of the morphologically complex (40b), as we have seen, and so its syntactic structure is nonbranching:



This root is listed in the morphological component as having two alternative pronunciations depending on its syntactic category, as in (43):

- (43) a. $\sqrt{\text{toor-}} \leftrightarrow [\text{toorike}]$
 b. $\sqrt{\text{toor-}} \leftrightarrow [\text{tooru}]$

The appearance of the "morpheme" [-ike] is determined by the morphological component and does not correspond to a piece of syntactic structure.

We can conclude that a theory of morphology which takes all cases of morphological complexity to correspond to syntactic complexity is too strong to account for the data. On the other hand, a theory which recognizes both an independent morphological module and a syntactic module of phrase-structure composition can make the appropriate discrimination to account for the observed pattern of facts in Kannada. Whether there is any systematicity

to the set of affixes which do not correspond to pieces of syntactic structure and whether there is any relationship between these affixes and any other phonological, syntactic or semantic properties remains to be investigated.

6 Conclusions

ER is a postsyntactic rule which, on the whole, does not distinguish between word-internal and word-external structure, suggesting that such a distinction is unnecessary. On this view, morphological complexity generally corresponds to syntactic complexity. We have noted, however, that certain cases of apparent affixation are not syntactically complex. A view in which all morphology is postsyntactic, such as Distributed Morphology, will require that some morphological structure is represented phrase-structurally and other morphological structure is due to nonstructural aspects of the syntax. This theory is superior to a lexical theory which treats the word formation component as wholly distinct from the syntactic component. It is also superior to a theory which eliminates a morphological component altogether by subsuming the functions of morphology into the syntax.

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The Distribution of the Old Irish Infix Pronouns: Evidence for the Syntactic Evolution of Insular Celtic?*

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1 Infix Pronouns in Old Irish

One of the most peculiar features of the highly intricate Old Irish pronominal system is the existence of three separate classes of infix pronouns used with compound verbs. These sets, denoted as A, B, and C, are not interchangeable: each is found with particular preverbs or, in the case of set C, under specific syntactic conditions. Below are listed the forms of these pronouns, adapted from Strachan (1949:26) and Thurneysen (1946:259-60), excluding rare variants:

	A	B	C
sg. 1	-m(m)'	-dom', -dum', -dam(m)' -tom', -tum', -tam(m)'	-dom', -dam'
2	-t'	-tot', -tut', -tat', -t'	-dot', -dat', -dit'
3m.	-a n-, -Ø n-	-t n-	-(d)id n-, -d n-, -Ø n-
f.	-s (n-)	-da h-, -ta h-	-da h-
n.	-a', -Ø'	-t'	-(d)id', -d', -Ø'
pl. 1	-n(n)	-don-, -ton-, -tan(n)-don-, -dun-, -dan(n)	
2	-b	-dob-, -dub-, -tob-, -tab	-dob-, -dub-, -dab
3	-s (n-)	-da h-, -ta h-	-da h-

Leaving aside for the moment the last set, which is limited to relative clauses introduced by a preposition (plus relative (s)a n-, with the sole exception of *i n-* 'in, in which') and after certain conjunct particles such as *día n-*, *ma* 'if, when', *cía* 'though, unless', *ara n-* 'in order that', *co n-* 'so that', and interrogative *in n-* (Pedersen 1913:145-7, Thurneysen 1946:258), it is

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generally agreed that the distribution of the first two classes is determined by the (prehistoric) phonetic shape of the individual preverbs. Those which ended in a vowel in Primitive Irish take class A, e.g., Wb. 5c6 *ním-charat-sa* 'they don't love me', 30d20 *imma-n-imcab* 'avoid him', 15a7 *na-chomalnid-si* 'fulfill it', 23d4 *rob-car-si* 'he has loved you (pl.)', 19d24 *dos-m-bérthe* 'ye would have given them'. Preverbs which ended in a consonant, on the other hand, are found with class B pronouns: cf. Ml. 39c27 *fritamm-orcat* 'they offend me', Wb. 6c16 *attot-aig* 'which impels you', Ml. 112a3 *cot-n-erba* 'he will trust himself', Wb. 31c16 *fordon-cain* 'teaches us', 5a13 *ata-samlibid-si* 'you (pl.) will imitate them'. The preverbs associated with each class and their reconstructed Primitive Irish, Proto-Celtic, and Proto-Indo-European shapes are the following:

Class A

ar· < PrimIr. *ari < PC *φari < PIE *prH-i

di·, do· < PrimIr. *dī < PC, PIE *dē

do· < PrimIr. *tu < *tū < PC *tō < PIE *tō (Schrijver 1995:17fn.2) or < PrimIr., PC, PIE *to (OHitt. *ta*)¹

fo· < PrimIr. *wo < PC *uφo < PIE *upo

im(m)· < PrimIr. *imbi < PC *ambi < PIE *h₂nt-b^hi (Jasanoff 1976; see Schrijver 1991 for raising of *a before nasal + voiced stop in pre-Old Irish.)

neg. *ní·, ní·* < PrimIr. *nē < PC, PIE *nē

no· < PrimIr. *no, *nu (?) < PC, PIE *nu

ro· < PrimIr. *ro < PC *φro < PIE *pro

Class B

ad·, ·ad-l-aC-l-á· < PC, PIE *ad

ad·, ·aith-l-aid· < *ati²

con·, ·com· < PrimIr., PC *kom < PIE *kom

¹See Schrijver (1995:17fn.2) for arguments in favor of a preform *tu. Note, however, that only *to is attested in Continental Celtic (J. Eska, p.c.), e.g., in Gaul. *to=me=declai natina* '(their) dear daughter set me up' (Voltino; see fn. 23) and as a sentence connective in Celtib. *ENIOROSEI VTA TIGINO TIATUNEI ERECAIAS TO LUGUEI ARAIANOM COMEIMV* 'To Eniorosis and to Tiatu of Tiginos the furrows, (and) to Lugus the farmland we dedicate' (Peñalba de Villastar; cf. Ködderitzsch 1985:216, Eska 1990a:106-7).

²The class B infixed pronouns used with *ad·, ·aith-l-aid·* < *ati are analogical to *ad·* < *ad.

as-, *·ess*-/*·eC*-/*·é*- < PrimIr. PC **exs* < PIE **ek*(s)

eter-, *·et(a)r*- < PrimIr. **edder* < PC **anter* < (post-)PIE **ṇ*-ter (Lat. *inter*)

for-, *·for*- < PrimIr. **wor* ← **wer* (probably on analogy of **wo* 'under')
< PC **uφer*³ < PIE **uper*

fri-, *·frith*-/*·freC*- < **writi*

in-, *·in(d)*- < PrimIr. **in* < PC **en* (?) < PIE **en*

as-, *·oss*- < PrimIr. **uxs*, **uss* < PC **uxs*, **uts* < PIE **up*(s) or **ud*(s)

It is highly surprising, then, that no explanation has yet been proposed for this clear phonological distribution. The standard handbooks call no special attention to these separate sets of infixated pronouns,⁴ and until recently (Schrijver 1997:131-9) there have been, to my knowledge, no efforts to provide a common origin and/or historical account of their coexistence.

Below I will first consider this problem from a purely phonological approach (section 2), from which it follows that the combinations of the preverb + infixated pronoun must originally have contained an intervening particle of the form *-(V)stV-. This reconstruction is strongly reminiscent of Cowgill's suggestion of **esti* as underlying the enclitic particle *-(e)s which he posited to explain the contrast between the Old Irish absolute and conjunct inflections; the phonological problems raised by such a preform will be examined in section 3. In section 4, Old British relics of the absolute/conjunct verbal contrast are adduced as support for Old Irish clause-second **esti*. Finally, I will outline the considerable implications of this hypothesis for the prehistory of the VSO syntax of Insular Celtic, and more generally for the evolution of Celtic constituent configuration (section 5). In particular, I will propose that all main clauses in declarative sentences were topicalized at the Proto-Insular-Celtic (PIC) stage, with **esti* in C(omplementizer) position and a preverb or simple verb obligatorily fronted to Spec-CP.

2 Phonological Reconstruction

As already noted, earlier scholars, beginning with Thurneysen, described the occurrence of the class A and B infixated pronouns with their respective pre-

³Probably on the analogy of **wo* 'under'; cf. Gaulish *Ver-cingeto-rīx* 'super-hero-king', Celtiberian *ver-amos* 'leader' (Schrijver 1995:120).

⁴Cf. Pedersen (1913:147), Lewis and Pedersen (1937:198), Thurneysen (1946:257-8), Strachan (1949:26), all of whom merely state the distribution as fact and list the individual preverbs which take class A or B.

verbs and noted the (exact) correlation between choice of class and final segment of the Primitive Irish preform.

Watkins (1963:26-8) suggests that an originally connective enclitic *de became fused with preverbs ending in a consonant, leading to the -d- of the class B pronouns, but retained its "quasi-independent status" after final vowels, allowing a distinction between e.g., 1sg. *ro-me (> class A *rom*·) and *ro-de-me (> class C *rodom*·, restricted to relative clauses and eventually becoming generalized there at the expense of class A). This descriptive account, however, fails to explain why sequences of consonant-final preverb + infixed pronoun, e.g., 1sg. *kom-me, 3sg. m. *kom-em, were lost and replaced by constructions with a particle that otherwise occurred only in relative function. Though the sort of phonologically conditioned occurrence of particles or morphemes proposed by Watkins for pre-Old Irish *de is not unknown in the world's languages,⁵ one would nonetheless prefer to seek some other origin for the observed distribution of class A and B endings without recourse to any *ad hoc* particles (or rather particles assumed to have followed an *ad hoc* pattern) at an earlier stage of the language. Most importantly, Schrijver (1997:132-4) has emphasized that *de could not have given the -t-, -d- [-d-] of the class B forms by sound change.

Let us approach the problem from a different, and apparently unrelated, area of Old Irish grammar, the verb. In his groundbreaking 1975 article on the absolute and conjunct verbal inflection of Insular Celtic and specifically Old Irish, Cowgill persuasively argues in favor of a derivation of conjunct forms from unsuffixed PIE primary endings, whereas absolute forms arose from the addition of a suffix *(e)s in Wackernagel position after a clause-initial verb: e.g., 3sg. conj. *·beir* < *beret < *bereti, abs. *be(i)rid* < *bereti+s (see also Cowgill 1985). Thurneysen (1914:29-30), who rejected Pedersen's (1913:340-1) view that the absolute forms resulted from enclitic subject pronouns, noted that "gemination" after *ní* 'not', i.e., *ní h-* < *nīs(t) < *nīsti < *nēsti < *ne esti, and other preverbs could be due to a postposed *s (see also Thurneysen 1946:152-3, 362-3). A particle of this shape explains the vast majority of attested endings in the OIr. absolute and conjunct paradigms. The lack of an obvious etymology carries little weight against such convincing phonological evidence, which itself must provide the basis for any etymo-

⁵So, for instance, the modern Korean subject-marking suffix is realized as -i after a consonant but -ka after a vowel, e.g., *che-ka* 'I' vs. *ur-i* 'we'; as -ka is not attested until the late 16th c., the two do not appear to share a common historical source (Lee 1977:251, 279). For another example cf. the distribution of Proto-Slavic *-no- and *-to- in OCS past passive participles: *-to- is found with unsuffixed sonorant-final and most semivocalic roots (e.g., *jetū* 'seized' to *jīm-, *bitū* 'beat(en)' to *bīj-), *-no- elsewhere (Schenker 1993:106).

logical conjecture (cf. Boling 1972:80-1, who takes the particle to be *(e)d; Cowgill 1975:54-6, 66-7, Schrijver 1994:180-1). Cowgill himself, on the basis of the attractive derivation of *ní* given above, suggests the 3sg. copula *esti 'it is', but agreed with Thurneysen that extension of *esti from the pass. pret., where it would have been expected (in e.g., *brethae in fer* 'the man is carried' < *britos-est' sindos viros vs. *ní breth in fer* 'the man isn't carried' < *nīst' britos), throughout the verbal inflection is difficult to explain (1975:66-7).

More recently, Schrijver (1994) has proposed an altogether different source for the Cowgill particle *(e)s. He begins with a plausible reconstruction of the OIr. prepositions *fri h-* 'towards, against', *la h-* 'with' from Proto-Celtic *writi, *(ϕ)leti via the stages *writ, *let (via early apocope of *-i, which Schrijver takes to be Proto-Insular-Celtic) and *wris, *les (through the Irish-only change of new final *-t > *-s).⁶ These two sound changes, which he then uses to explain the long troublesome 3sg. relative forms of OIr., allow for a derivation of *(e)s from the PIE connecting particle *eti, attested in Skt. *āti* 'beyond', Gr. *éti* 'still, yet', Lat. *et* 'and', Goth. *ip* 'and, but', and in Celtic as Gaul. *eti* 'also, likewise' and *etic*, *eðdic* 'and' < *eti=k^we. Schrijver adduces apparent support for this etymology from British forms which have an alternant with final -d before a following vowel-initial word, e.g., MW *nyt* [-d] 'not' for *ny* before a vowel-initial verb in main clauses, *neut* for *neu* (preverbal particle, spirantizing), MB *ned* 'not' for *ne* before vowel-initial forms of 'be' and 'go'. These latter, which Schrijver assumes to be the direct phonological counterpart to the *h-* of OIr. *ní h-* 'not' and initial *h-* in e.g., *do-ic* [do híg] 'reaches', would require a PIC preverbal *et < *eti.⁷

Returning to the problem at hand, it is not difficult to see that neither *es/*is nor Schrijver's hypothetical *eti can explain the distribution of infixated pronouns found with OIr. preverbs. Whether or not one wishes to identify it with a masc. sg. anaphoric pronoun, *es (*is) leaves the -d- of class B utterly without a source. On the other hand, a particle *eti is highly unlikely to have resulted in the class A pronouns unless we make the improbable as-

⁶The British cognates of *fri h-* are Old Welsh *gurth* (Mid. (g)wrth, Mod. wrth), Middle Cornish (w)orth, Old Breton *gurth* (Mod. ouzh), reflecting Proto-British *wurt < *wurt < *writ (by metathesis) < *writi (Thurneysen 1946:515, Jackson 1953:337; cf. W *gwr* 'man' < *wur < *wiros). OIr. *la h-* has no direct British cognate, though both Irish and British preserve the derived s-stem noun *pleth₂os, *-es- in OIr. *leth* (n.) 'side, half', W *lled*, C *les*, B *led* (m.) 'width, half' and adj. *p_lth₂-no- > *litano- in OIr. *lethan*, W *llydan* 'wide' (cf. Gaul. *litano-*).

⁷Under this analysis, MW *nyt*, MB *ned* 'is not', OIr. *ní h-* continue, not *ne-esti as usually assumed, but *ne-eti esti.

sumption that the *s proper to enclitic (final) *-es < *-et < *eti was introduced into internal position in the putative preforms of vowel-final preverbs, e.g., 1sg. *ro-(e)ti-me, 3sg. m. *ro-(e)t-en < *ro-eti-en, but not in those of consonant-final preverbs, e.g., 1sg. *kom-eti-me, 3sg. m. *kom-et(i)-en (Schrijver 1997:135).⁸ For the forms of *kom, he thus has to assume that "the *e of the particle was lost before PrIr. *-t became *-s ... I propose an *ad-hoc* sound law, by which in a PrIr. proclitic group of more than two syllables the vowel of the second syllable (in this case *e of *et) was regularly lost as a result of an early syncope."⁹

Note also that whatever solution is proposed must account for the contrast between class A -s (n-) and class B -d-a (n-), -t-a (n-) in the 3sg. fem. and 3pl., as well as between class A -a n-, -a' and class B -t-Ø n-, -t-Ø' in the 3sg. masc. and nt. Watkins (1965:287) takes the first pair back to "coexisting feminine anaphoric stems *siya- and *iya- in Celtic" (and by extension presumably pl. *siyo- and *iyo- as well?), but it would be remarkable at least for two distinct stems to have survived in *identical* function and then been partitioned according to a purely phonological criterion without any apparent motivation. Schrijver (1994:183-4), following Watkins's hypothesis of a particle *de underlying the class B pronouns, implicitly treats this problem as it affects the preverb *friss-*: 3pl. *frita-* < *writi-de-sons vs. e.g., *dos-* < *tu-es-sons; the arguments against such a complementary distribution of *de and *es have been raised above.

In seeking a unitary origin for the two classes of infixed pronouns, we must ask what preform of a particle in second position (following the preverb) would have disappeared after a vowel but given -d- after a consonant. Intervocally, *s was weakened to *h and disappeared, probably already in Proto-Insular-Celtic; cf. OIr. *tige*, MW *tei* (ModW *tai*) < PIC *tege'a¹⁰ <

⁸Contra Schrijver, such analogical spread is necessary for *ro-(e)ti-me, *ro-(e)t-en, as *-t- here was hardly at the end of a phonological word. Schrijver has apparently rescinded his earlier view (1994:183-4), which followed Watkins in assuming a particle *de in complementary distribution with *es < *eti, hence e.g., 1sg. *kom-de-me, 3sg. *kom-d(e)-en to *kom.

⁹Schrijver (1997:177-8) attempts to adduce further support for *eti from Gaul. pret. 3sg. *legasit* 'offered', which he takes from *leg-ā-s-ti=t < *leg^h- (*-t < *-eti). This is not the only possible analysis, however: K.H. Schmidt (1983:79, 1986:167-8) derives it from thematized *leg-ā-s-e-t or *-s-t+et. The form therefore cannot be used as evidence for or against the particle *eti in Gaulish.

¹⁰Or perhaps already *tegi'a? The OIr. development was *tege'a > *tegi'a (> *tegiya) > *tigiya (raising) > *tigeya (lowering) > *tige*. For raising of pre-OIr. *e > *i in hiatus before a back vowel cf. OIr. gen. sg. *niad* 'nephew', Ogam NIOTTA < *ni'otas < *ne'otas < *nepotos. On the Welsh form, which presupposes a like raising

*tegesa. But intervocalic *st became *ss in the prehistory of Old Irish as well: cf. *is* 'is' < *esti < *h₁esti, *·sissedar* 'places' < *si-sta- < *s(t)i-sth₂-, (Thurneysen 1946:96). If the resulting *ss was simplified to *s in pretonic position—certainly a very plausible and phonetically natural development—early enough, this new *s could have participated in the weakening of intervocalic *s > *h.

If we ask ourselves what would have happened to such a cluster *st after a consonant, we can make reference to by now well-established sound laws. In a sequence consisting of *r, *l, or *m, *s would have been lost, giving *rt, *lt, and *mt, respectively. This change is most familiar from the 3sg. pret. of verbal roots ending in these consonants, where, as Watkins astutely demonstrated (1962:169-74), the resulting final *-t was reinterpreted as a marker of preterite inflection (with zero-ending of the 3sg.) and spread to the other forms of the original *s*-aorist paradigm, leading to the creation of the Insular Celtic *t*-preterite: e.g., 3sg. *berst > *bert > *·bert*, whence 1sg. *bers-m̄ → *bert-a (vel sim.) > *bert*, 3pl. *bers-nd → *bert-oddar > *bertatar*.¹¹ Stem-internal examples of such *s*-deletion, which Watkins adduced in support of his conclusion, include OIr. *tart* 'thirst' < *tarsto- < *t̥rsto- (OHG *durst*) and *arco* 'I ask for' < *parsk- < *pr̥sk- (Lat. *poscō* 'I demand', Skt. *pr̥cchati* 's/he asks'; PIE *pr̥sk- < **pr̥k-sk-, cf. Lat. *precēs* 'prayers'); see Pedersen 1909:80-1 for other, less secure cases.

The same loss of *s is found in PC *xst < *kst,¹² e.g., OIr. *echtar* 'outside' < *eks-tero- (and other compound of *eks- with *t-initial roots),

of hiatus *e > *i, cf. Schrijver 1995:390-2.

¹¹I leave aside the vexed question of the origin and preforms of the 2sg. and 1, 2pl. endings of the *t*- and suffixless preterites. Note that the lengthened grade reconstructed for the PIE sigmatic aorist on the basis of Indo-Iranian, Slavic, and Tocharian may also have survived in (Insular) Celtic and into the prehistory of Irish, contra Watkins 1962:21-2: otherwise one would not expect 3sg. perf. *ru-bart* < *ru bert ← *ru birt < *ro birt (vowel raising) < *birt < *bērt < *bēr-s-t (Don Ringe, p.c., following a suggestion of Warren Cowgill). For brief discussion see McCone 1986:231. (Note here that the sigmatic aorist of OCS *vezp* 'I convey' < *weǵh-is attested in Serbian CS 3du. *otivěsta se* 'the two of them sailed off', translating Gr. *apépleusan*, thus confirming the word-equation with 3sg. Skt. *āvāt*, Lat. *vēxit* 'carried, conveyed' (contra Watkins 1962:41).)

The loss of *s in these clusters may have been of Proto-Celtic date: cf. Gaul. (Lezoux) *loberte* 'brought' ← *ber-s-t < *b^her-, which, if correctly read by Thurneysen, provides another source of the Gaul. *t*-pret. (Eska 1990b:85-6 with refs.), and Celtib. (Botorrita A1) *ComPalCes* < *balsk- < *b^hjs-sk- or *b^hjs-k- (Hamp 1989).

¹²And presumably also pre-PC *pst, though good examples are lacking.

úachtar 'upper part' < *uks-tero-, and the *t*-preterite of velar-final roots such as *aingid* 'protect' and *agid* 'drive', respectively *·anacht* (Wb.) and *·acht* (McCone 1986:232-3, refuting Watkins 1962:143-4). The *t*-preterites of the British languages such as W 3sg. *aeth* 's/he went' < *axt < *axst (pret. of *mynd* 'go'), an exact cognate of OIr. *·acht*, strongly imply an Insular Celtic date for this phonetic change and possibly the resulting paradigmatic remodeling. Least certain is the phonetic outcome of *tst, at least in Insular Celtic,¹³ but here we have one fairly secure etymology: *at-tá* (*atá*) 's/he is' (substantive) < *atstā- < *ad-steh₂- 'to stand at/to', cf. Lat. *astat* 'stands at/by/near'.¹⁴

If we compare these sound rules with the forms of those originally consonant-final preverbs which take class B infixed pronouns, a striking pattern emerges:

preverb	preposition	with infixed pronoun
<i>con·, ·com-</i>	<i>co n-</i> < *kom	<i>cot-om', -ot', -a...</i>
<i>eter·, ·et(a)r-</i>	<i>eter</i> < *edder	<i>etart-om', -ot', -a...</i>
<i>for·, ·for-</i>	<i>for</i> < *wor	<i>fort-om', -ot', -a...</i>
<i>in·, ·in(d)-</i>	<i>i n-</i> < *in	<i>at-om', -ot', -a...</i>
<i>ad·, ·ad-l-aC-l-á-</i>	— < *ad	<i>at-om', -ot', -a...</i>
<i>as·, ·ess-l-eC-l-é-</i>	<i>a h-</i> < *es	<i>at-om', -ot', -a...</i>
<i>as·, ·oss-</i>	— < *us, *uss	<i>at-om', -ot', -a...</i>
<i>fri·, ·frih-l-freC-</i>	<i>fri h-</i> < *writ	<i>frit-om', -ot', -a...</i>

With the exception of the voicing of the component *-t-* [-d-] of the class B person/number endings, which is regular and expected in pretonic position (Thurneysen 1946:111; see section 3), the agreement between the expected outcomes of *-Cst- and the actually attested forms of preverb + infixed pronoun is complete.

Such an exact and systematic correspondence is unlikely to be fortuitous. Although a following *de (as proposed by Watkins and advocated by Schrijver) could account for the shape of the above preverbs as well, the obvious advantage of a particle containing *-st- is its potential to account for *both* classes A and B of infixed pronouns (almost) exclusively by sound change. The phonological details of this hypothesis will be pursued in detail below.

¹³Pre-PC *tst appears to have become *ts and then the "tau Gallicum" phoneme in Gaul.; cf. Eska 1998 with refs.

¹⁴The initial *t-* of conjunct *·tá*, and perhaps also W *taw*, is abstracted from this compound, contra Jackson 1953:530.

3 Enclitic *esti in Clause-Second Position?

The reconstruction of a particle containing *-st- which originally followed the initial preverb in Wackernagel position in the clause immediately recalls Thurneysen's and Cowgill's idea of tracing postverbal *-(e)s to the copula *esti 'it is', and indeed it is hard to see what other etymological source a particle of this shape could have had. Below we shall trace the stages in the evolution of the prehistoric complex of preverb + *esti + infix pronoun and attempt to determine the developments which must have taken place under this hypothesis. So as to be able to follow the prehistories of classes A and B in parallel, I have chosen *ro-* and *com-* as representative of vowel- and consonant-final preverbs, respectively.

After *esti had become fixed in clause-second position at the Insular Celtic stage, the preverbal complexes must have been these:

sg. 1	*ro-(e)sti-me?	*kom-esti-me?
2	*ro-(e)sti-te?	*kom-esti-te?
3m.	*ro-(e)st(i)-en	*kom-est(i)-en
f.	*ro-(e)sti-sen	*kom-esti-sen
n.	*ro-(e)st(i)-e	*kom-est(i)-e
pl. 1	*ro-(e)sti-nus	*kom-esti-nus
2	*ro-(e)sti-wus	*kom-esti-wus
3	*ro-(e)sti-sus	*kom-esti-sus ¹⁵

When combined with a preverb ending in a vowel such as *ro, the first vowel of *esti was almost certainly elided; cf. Cowgill's reconstruction of the postverbal particle as *(e)s, i.e., *es after consonants (e.g., 2pl. *beretes-es > *beirthe*) vs. *s after vowels (e.g., 1sg. *berū-s > *biru*). The surface variant *-st(i)- of the original copula *esti thus came to be used with *ro, *tu, *di, *nu, etc., hence with a majority of preverbs in the language.

I propose that the consonant-final preverbs altered the second component *est(i) of their preverbal complexes to *st(i) on the model of the vowel-final

¹⁵The reconstruction of the person/number infix pronouns will not be dealt with in detail here. As already pointed out by Thurneysen (1904:114), final *-d in 3sg. neut. *-ed must have dropped early enough to trigger lenition; here this loss has been tentatively ascribed to Insular Celtic. I here reconstruct *-e < *ed, cf. the 3sg. neut. pron. *ed* 'it' < *ed-V-, following Watkins 1969. On 3sg. fem. *sēn < *seyen < *seyan < *seyām (cf. OHG *sia*, Lat. *eam*) see Watkins 1965:287, Boling 1972:87; sim. 3pl. *sūs < *sōs < *sons. These then became *sen and *sus by shortening of unaccented long vowels; cf. Cowgill 1975:49-50.

type, resulting in the following preforms (with assimilation of nasal *m to *n before now adjacent *s):

sg. 1	*ro-sti-me?	
2	*ro-sti-te?	*kon-sti-me?
3m.	*ro-st-en	*kon-sti-te?
f.	*ro-sti-sen	*kon-st-en
n.	*ro-st-e	*kon-sti-sen
pl. 1	*ro-sti-nus	*kon-st-e
2	*ro-sti-wus	*kon-sti-nus
3	*ro-sti-sus	*kon-sti-wus
		*kon-sti-sus

It remains to be seen whether such a small assumption of analogical remodeling will prove sufficient to derive the attested inflexions of pre-PIC stage, would

Next, suppose that intervocalic *st > *ss. This change, which occurred in both Irish and British and may therefore be dated to the pre-PIC stage, would have affected only the first column of preforms, producing sg. 1 *ro-ssi-me, 2 *ro-ssi-te, 3 masc. *ross-en, fem. *rossi-sen, etc. Preverbs ending in a vowel such as *tu and *di. similarly for all other

Consonant-final preverbs, however, would have been subjected to loss of *s between a sonorant and *t, as in *tart* 'thirst' < *tarst-, and those PIE and PC sigmatic aorists which have been subjected to loss of *s, as in *arco* 'I ask for' < *archo-, gave rise to the disjunctive *t*-preterite of OIr. and British; cf. section 2 above. These two developments would have produced the following:

sg. 1	*rossime?	
2	*rossite?	kontime?
3m.	*rossen	kontite?
f.	*rossisen	konten
n.	*rosse	kontisen
pl. 1	*rossinus	konte
2	*rossiwus	kontinus
3	*rossisus	kontiwus
		kontisus

I then posit a degemination of intervocalic *ss in the conjugated forms of *ro to *s. Syncope between like consonants then affected the 3sg.f. and 3pl., producing *rossisen > *rosisen > *rossen and *rossisus > *rossis, respectively. This is the early syncope first proposed by Meid (1972:350-1) to account for the unlenited final /-d/ in the pres. conj. 3sg. of dental-final verbal roots,¹⁶ e.g., *neget* 'prays' < *nig^wedd < *nig^wedit < *nig^wediti, and

¹⁶Though probably not in *tét* 'goes', the exact origin of which remains unclear

restricted by Cowgill (1980:58) to position after an unstressed syllable, hence $*-V_1TV_2T(-) > *-V_1TT(-)$ where $*V_1$ and $*V_2$ are both unstressed—clearly the case above. The remaining person-number forms of $*ro$, and the 3sg.f. and 3pl. of $*kom$ -, then underwent the normal weakening and loss of intervocalic $*s$, likewise shared by Irish and British, e.g., in OIr. pl. *tige*, MW *tei* < $*tege'a$ < PC $*tegesa$, OIr. *sieir*, MW *chwior(-ydd)* < $*swe'oreh$ < PC $*swesores$ 'sisters'. So far as can be determined, this was the state of affairs in the Primitive Irish period:

sg. 1	$*ro'ime?$	$*kontime?$
2	$*ro'ite?$	$*kontite?$
3m.	$*ro'en$	$*konten$
f.	$*rossen$	$*konti'en$
n.	$*ro'e$	$*konte$
pl. 1	$*ro'inus$	$*kontinus$
2	$*ro'iwus$	$*kontiwus$
3	$*rossus$	$*konti'us$

The subsequent development of these preforms from Primitive to Old Irish is not entirely certain. The compounds of $*kom$ may have given *condom'*, *condot'*, *cond n-*, *conda n-*, *cond'*, *condon*, *condob*, *conda h-*¹⁷ by final apocope, or rather syncope of the vowel immediately preceding the stressed syllable—a natural pretonic extension of the regular and productive syncope rule of Old Irish deleting vowels in alternating syllables after the stress (see Thurneysen 1946:67 for some typical examples)—but it is hard to see why pretonic $*i$ would have given only back *a*, *o*, or *u* (see the table in section 1). This same rule will also explain 3sg. f., 3pl. *ros (n-)* < $*rossen$, $*rossus$, but not the other person-number compounds of vowel-final preverbs such as $*ro$, in which $*i$ must have somehow been syncopated. I leave the solution of these and other remaining phonological difficulties for future research. The final sound change affecting initial preverb + infixed pronoun was the voicing of $*t > [d]$ in pretonic position, which affected all obstruents other than $*s$ (Thurneysen 1946:111; Cowgill 1975:54fn.11).

(Cowgill 1980:58fn.10); for a recent proposal see Schrijver (1993:42-6), who takes $*tét < *(s)tinx-ti < *(s)tingh-ti$ to the PIE root $*steyǵh-$ 'go up' (Gr. *steikhō* 'I walk, step', Goth. *steigan* 'ascend, climb up', OCS *stignō* 'I'll reach').

¹⁷The distinction in mutation between the 3sg. f. and 3pl. was effaced already by the Old Irish period, in which we find class A *-s (n-)* and class B *-a h-* in both contexts; see Thurneysen 1946:261ff. for examples. I cannot now account for the generalization of *h-* in class B vs. optional nasalization in class A.

Clearly some of the above developments have had to be assumed, and their relative chronology appears almost totally *ad hoc*: the changes have been presented in the order necessary to derive the required forms. A systematic investigation of the prehistory of that other major class of pretonic particles, the notorious Old Irish copula, should alleviate this drawback by providing an independent comparandum for, and hopefully confirmation of, the relative ordering of these sound changes.

These reservations aside, the foregoing has served to demonstrate the plausibility of explaining the contrast between classes A and B of infixed pronouns by positing a mandatory clause-second **esti*. At this point, one should be reminded that the Cowgill particle *-(e)s can also be straightforwardly derived from **esti* by early PIC apocope of final *-i and simplification of the new final cluster *-st > *-s. I am not aware of any direct parallels for the latter change, but nor are there any counterexamples; other instances of final *-sti must have been extremely rare (or nonexistent) in any case.¹⁸

4 Evidence from British

Due to the limited extent and fragmentary nature of our surviving Old British documents and the substantially greater loss of overt morphological marking (e.g., the disappearance of case-marking in the noun or almost complete elimination of the absolute/conjunct distinction in the verb), it is not surprising that Old Irish provides by far the best evidence for the syntactic structure of an earlier stage of Celtic. Nevertheless, traces of an earlier Proto-British twofold verbal paradigm survive, e.g., in MW *trenghit golut, ny threingk molut* (RBH 1082) 'wealth perishes, fame perishes not', *egid* (Computus), MW *eyt* 'goes' or in OB glosses such as *fleriot* 'smell of' < *-āti+s, *trouit* 'returns, withdraws' < *-iti+s (Fleuriot 1964:300; Pedersen 1913:338, 343, Lewis and Pedersen 1937:283)¹⁹, which match OW and MW forms in -*awt*, -*awd*, -*aud* and -*it*, -*id*, respectively (Simon Evans 1964:118-9). These relic forms agree in preserving a dental-final ending that must go back to abs. *-ti+s rather than conj. *-ti > *-Ø, from which the usual Middle and Modern British 3sg. endings are descended.

¹⁸A parallel for *-st > *-s occurs in Gaul. pret. 3sg. *prinas* < *k^wri-n-h₂-s-t (La Graufesenque) or *readdas* (Argenton-sur-Creuse). Thanks to Joe Eska for bringing these forms to my attention.

¹⁹See Fleuriot 1985:171, 323 respectively for details. The OB glosses *eit*, *egit* 'goes', if correctly interpreted, match OW *egid*, MW *eyt* (but cf. Fleuriot 1985:156, 155).

As Cowgill has shown, the presence vs. absence of a particle *(e)s in clause-second position will also account for Old British relic forms such as those above, as well as the *s*-preterite (Cowgill 1975:63-4). Clearly, however, the often fragmentary and sparse data of older British constitutes less probative evidence than that of Old Irish, and adds little further support to the hypothesis of an original particle *esti.²⁰

If this is correct, it follows that at least Irish and British have shared in the syntactic innovation by which *esti came to stand in second position in most clauses. This development, which is unlikely to have occurred independently, would therefore provide additional support for the Insular Celtic hypothesis, according to which Irish and British comprise a separate subgroup of Celtic (cf. most recently McCone 1992, 1996:98-104). Though we cannot perhaps entirely rule out the possibility that "esti-second" arose earlier in the history of Celtic, say in the "Nuclear Celtic" ancestor of Gaulish, British, and Irish,²¹ the lack of any trace of *esti or its syntactic effects in the attested clausal configuration of Gaul. (see Eska, forthcoming) speaks in favor of an Insular Celtic innovation.

²⁰One obstacle to deriving the OBr. absolute forms from postposed *esti is that the treatment of intervocalic *st in British is problematic: among words both *s(s)* and *st* seem to occur, with no discernable conditioning factor distinguishing the two outcomes (Pedersen 1909:78-80, 136; Lewis and Pedersen 1937:20-1, 47, Jackson 1953:529-34, 1967:756fn.1). Cf. for example W *gwas* 'servant', MC *gwas* 'boy', B *gwaz* 'man, servant' (OIr. *foss* 'servant'; cf. Medieval Lat. *vassus*, the source of Engl. 'vassal') < *wosto- < *upo-sth₂-o 'standing under' vs. W *clust* (f./m.) 'ear' (OIr. v.n. *clúas* 'hearing') < *klowstā or sim. After discussing the relevant examples and eliminating what he believes to be doubtful or false etymologies, Schrijver (1995:414-5) observes that "all alleged instances of PBr. *-st- ... belong or may belong to a root ending in *s"; he explains this pattern by postulating that these PBr. *-st- reflect *-s-st-, i.e., root-final *s followed by a suffix in *-st- (on which see pp. 406-7), though it is also possible that *s could have been analogically restored in these words after the change of *VstV > *VssV. He therefore concludes that "there can be no doubt that the regular reflex of PCl. intervocalic *-st- in British is *s*", or rather *ss. Even if the evidence may perhaps be less clear-cut than presented by Schrijver, observe that we have two solid examples of *st > PBr. *ss between unstressed vowels: MW *ys* 'is' (OIr. *is*) < *esti+s, originally enclitic, and *s*-pret. 3sg. W, C, B -s (OIr. abs. -(a)is) < *-st+es. There is thus good reason to believe that *st in pretonic (attached to the first preverb) or posttonic position (after a simplex verb) would have developed to *ss, whence degeneration to *s.

²¹As pointed out to me by Don Ringe. The use of the term "Nuclear Celtic" for the ancestor of all (continental and insular) varieties of Celtic following the separation of Celtiberian is also due to him. Below I shall continue to use "Insular Celtic" to denote developments common to British and Irish.

5 Syntactic Consequences

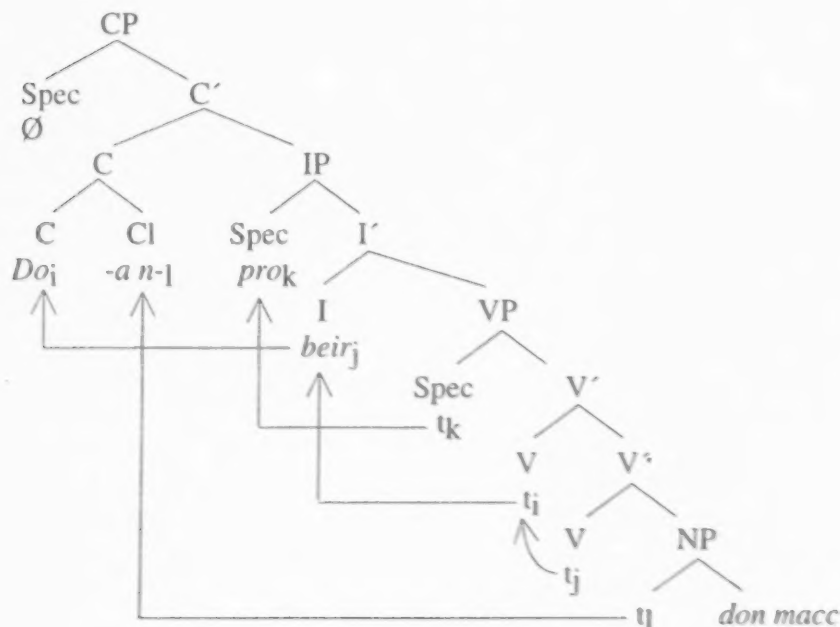
If the postverbal "Cowgill particle" and the distribution of class A and B infixed pronouns do indeed descend from near-obligatory clause-second placement of the PIE copula **(h₁)esti*, this has major consequences for our understanding of the prehistory, not only of the verbal system, but of the constituent configuration of Celtic as well. As Cowgill himself noted at the end of his 1975 article (1975:68fn.22), Paul Thieme had remarked that "the obligatory use [of **esti*] in most clauses may have grown out of a usage similar to that of Sanskrit *asti* 'it is the case that'", e.g., in Patañjali, *Mahābhāṣya* I 230.19ff.: *kaścit ... pr̥cchati: asty atra kā m̐cid gām payasī* "Somebody asks: 'Is it [that] you see here a certain cow?'" namely "do you actually see, do you see?". For further examples and discussion see Thieme 1965:90-1.

Put another way, it would appear that at some point in the prehistory of Irish, main clauses of declarative sentences were transformed by a cleft construction, in which the first preverbal particle (of a compound verb) or a simple verb was fronted to initial position. As traces of this same **esti* are also found in British (see section 4), we may infer that this syntactic change was completed before the breakup of the last common ancestor of British and Irish.

This proposal has consequences for the developments which took place during the evolution of VSO configuration in Insular Celtic. Carnie, Pyatt, and Harley (1994) present evidence that the VSO order of Old Irish (and Old Welsh) results from a "weak verb-second (V2)" constraint which requires the C(omplementizer) slot to be filled with overt phonological material at surface structure (s-structure). For compound verbs, this constraint is fulfilled by raising the first preverb to C, as already suggested by McCloskey (1978); in the absence of a preverb, the simplex verb itself moves to C, where it assumes a special clause-initial, i.e., absolute, inflection. Object clitics—in practice principally pronouns—adjoin to C, giving the familiar infixed pronouns after a preverb and suffixed pronouns after a clause-initial simplex verb, a contrast fully preserved in Early Old Irish. Because the specifier of CP must remain empty (unlike, say, in the Germanic languages, where some XP is fronted to produce verb-second order—hence the "weak V2" constraint), this movement to C, in addition to the V-to-I raising known from Modern Irish, accounts fully for the VSO order of Old Irish. Below I give examples for sentences (1) and (2).

Recently, Eska (1994) has proposed a model for the historical evolution of Celtic constituent configuration, from the SOV order reconstructed for PIE and Proto-Celtic and attested in Celtiberian, through the underlying SVO

- (2) *Da-mbeir* *don macc.*
 Gives it (pres. ind. 3sg. deut.) to-the boy (dat.)'
 lit. 'to-it (masc.)-brings'
 'He gives it to the boy.'

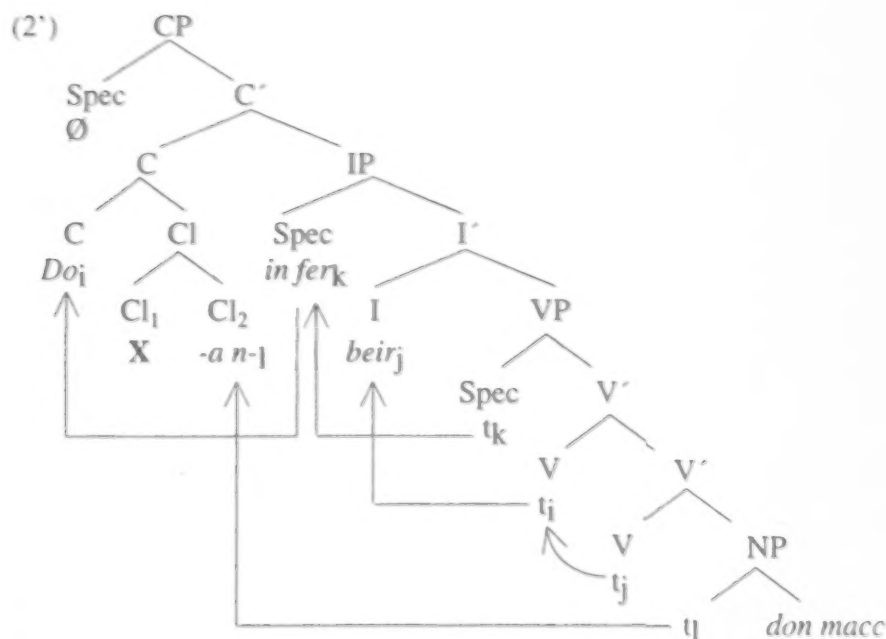
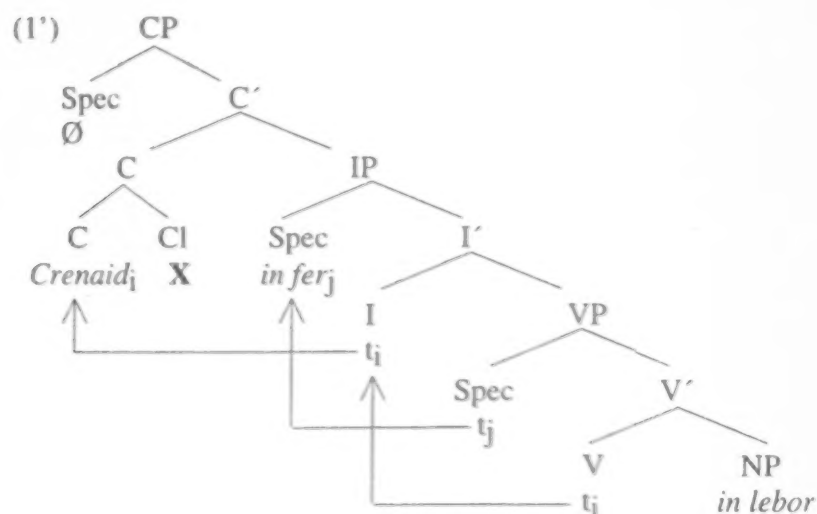


Such cases, Eska suggests, apparently led to a generalized rule of V-to-C movement in Insular Celtic, with the innovation being a requirement for C to be filled at s-structure.

In light of the evidence from the distribution of Old Irish infixed pronouns for a requirement of clause-second *esti at some point in the prehistory of the language—a hypothesis supported by the success of the Cowgill particle *es < *esti in explaining the contrast of absolute and conjunct verbal inflections in Insular Celtic—these views, both synchronic and diachronic, may be slightly modified. Specifically, this evidence suggests that, at some point in time, the *esti found at C in cleft constructions became obligatory, along with the raising of the first preverb or simple verb to provide overt phonological matter in C. Vendryes's Restriction, or rather Eska's (1994:32) description of it as "requir[ing] the verb to host clitic pronominal objects syntactically,"²³ then had the effect of raising the verb to C in compounds

²³As Eska observes, the "Bergin's Rule" and tmesis constructions of Early Old Irish (which survive into the 8th and 9th centuries; see Greene 1976) must then reflect "manifestations of residual grammars no longer in active use in vernacular speech, but

such as *da-mbeir* in (2). The revised configurations for sentences (1) and (2) are therefore (1') and (2') below, where **X** stands for the "Cowgill particle", originally *esti.



preserved for literary use, i.e. they are genuine archaisms" dating from the time before Vendryes's Restriction became obligatory (32-3).

Since V-to-C movement is believed to have been triggered by a requirement for C to be lexicalized, i.e., to contain overt phonological material, one might assume that **X** itself does not satisfy this requirement. Yet it is clear that **X** is realized phonetically as [-h-] in compound verbs such as *do·ic* [do híg'] 'reaches', and the combination of preverb and **X** results in the form to which the enclitic pronoun is attached; moreover, the distinction between verb and **X** and bare verb underlies the absolute/conjunct contrast of the OIr. verbal system. Further study should shed more light on the exact status of **X**, both syntactic and phonological.

The changing status of **X** may help to account for some of the syntactic developments postulated for the prehistory of OIr. Whereas Carnie et al. (1994) give no syntactic (or morphological) motivation for their "weak-V2" constraint, Heidi Harley has recently suggested (p.c.) that V-to-C movement may have been motivated in order to host **X** (i.e., *es < *esti) after its phonological reduction to clitic status and the consequent loss of cleft syntax. Later, as the Cowgill particle became phonetically fused into preverbs and absolute verb forms and morphologized as the absolute-conjunct or proto-tonic-deuterotonic contrast, verb movement became feature-driven, resulting in a genuine "weak-V2" constraint in OIr. This would have the benefit of deriving V-to-C movement universally in main declarative clauses, versus Eska's (1994) generalization from Vendryes's Restriction in sentences containing pronominal objects.

Obviously much of the above is far from fully established: in particular, the exact phonological details of pretonic sequences of preverb + *esti + pronoun (section 3) remain to be worked out, and the status of the always tricky "Bergin's Law" constructions may need to be interpreted somewhat differently. Among the many questions awaiting discussion, I will mention only the apparent absence of *esti in the "responsive", i.e., the first sentence in response to a question, in which a simple verb occurs in conjunct instead of absolute inflection. Here Schrijver's account (1994:184fn.23) is undeniably attractive: whereas discourse-internal clauses would regularly have employed *eti, the first clause would naturally have dispensed with any such connecting particle. Nevertheless, the brief discussion above should hopefully demonstrate how the hypothesis of an obligatory *esti in clause-second position fits with much of the syntactic research to date on the prehistory of VSO configuration in Old Irish and Insular Celtic, including the "weak-V2" hypothesis of Carnie et al. (1994) and Eska's formulation of Vendryes's Restriction. As so often in the case of Irish, the massive accumulation of sound change has all but effaced the original shape of a morphological element, leaving behind two sets of verbal inflections and an otherwise inexplicable distribution of infixed pronouns as our only remaining clues to its prior existence.

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Discourse Saliency and Pronoun Resolution in Hindi*

Rashmi Prasad and Michael Strube

1 Introduction

This paper investigates anaphoric reference in Hindi, with particular focus on the use and interpretation of third person personal pronouns to realize anaphoric relationships between noun phrases. We have two specific goals. The first is inspired by the central idea of Centering theory (Grosz et al. 1995), namely, that each utterance in a discourse evokes certain discourse entities (Webber 1978; Prince 1981) which comprise the list of *forward-looking centers* (the *Cf*-list), in Centering terms, and which are ranked according to their saliency. The anaphoric relationships in the local discourse segment (Grosz and Sidner 1986) are dependent on the *Cf*-list ranking, in that the more highly ranked entities in an utterance are more likely to be talked about in the following utterance. Investigation of the factors that determine the *Cf*-list ranking—which have not yet been completely specified—has, therefore, constituted an important aspect of the research for Centering theory in particular, and for discourse anaphora in general. Furthermore, crosslinguistic research has revealed that this ranking is dependent on language specific factors (Walker et al. 1994; Turan 1995; Strube and Hahn 1999, among others). Our purpose here is to investigate such factors in Hindi, with special focus on the role of grammatical function, word order, and information status. We also propose a novel, general method for determining these ranking factors.

Centering theory has also guided the development of pronoun resolution algorithms, such as the BFP algorithm and the algorithm developed by Strube (1998, henceforth, S-list algorithm). Both algorithms regard the notion of relative saliency to be crucial for the resolution of pronouns, and in order to apply these algorithms for pronoun resolution in any language, the first task is to be able to determine the *Cf*-list ranking criteria for that language. Our second goal, therefore, is to apply these algorithms to the resolution of pronouns in Hindi texts by incorporating the results of our analysis of relative saliency in Hindi. In doing so, we show that the BFP algorithm cannot be successfully implemented for pronoun resolution in Hindi and that, in fact, the same-prob-

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lems extend straightforwardly to an implementation of this algorithm in any other language. We argue that better results can be obtained with an algorithm that does not use the Centering notions of the *backward-looking center* and the *centering transitions* for the computation of pronominal antecedents, such as the S-list algorithm proposed by Strube (1998).

Section 2 presents a brief overview of Centering theory. In Section 3, we present our method for determining relative salience, and show that *grammatical function* is a crucial factor for ranking discourse entities in Hindi, with word order and information status having no independent effect on salience. In Section 4, we present the BFP algorithm and discuss the problems that it presents for pronoun resolution, using examples from Hindi as an illustration. In Section 5, we describe the S-list algorithm and adapt it to results obtained for Hindi. Finally, in Section 6, we compare the performance of the two algorithms for the resolution of pronouns in Hindi texts.

2 Centering Theory

Centering theory is a model of local discourse coherence which makes predictions about the inference load placed on a hearer in processing a discourse segment. The crucial claims of the theory are as follows:

- Discourses are composed of constituent segments, each one of which consists of particular utterances.
- Each utterance U_i in a given discourse segment is assigned a list of *forward-looking centers*, $Cf(U_i)$, where *centers* are semantic entities in the discourse model (Webber 1978).
- Each utterance (other than the segment-initial utterance) is assigned a unique *backward-looking center*, $Cb(U_i)$.¹
- The list of *forward-looking centers*, $Cf(U_i)$, is ranked according to discourse salience, with the highest ranked element of $Cf(U_i)$ being called the *preferred center*, $Cp(U_i)$ (Brennan et al. 1987).
- The most highly ranked element of $Cf(U_{i-1})$ that is *realized* in U_i is the $Cb(U_i)$.²

¹The Cb corresponds to the discourse entity that the utterance is most centrally about, and is similar to the notion of the *topic* (Reinhart 1981; Horn 1986).

²An utterance U *realizes* a center c if c is an element of the situation described

The theory defines transition relations across pairs of adjacent utterances (see Table 1, taken from Walker et al. (1994)). The transitions differ from each other according to (a) whether Cb 's of successive utterances are equal or not, and (b) whether the Cb of any utterance corresponds to the Cp of that utterance or not.

	$Cb(U_i) = Cb(U_{i-1})$ OR $Cb(U_{i-1}) = [?]$	$Cb(U_i) \neq$ $Cb(U_{i-1})$
$Cb(U_i) =$ $Cp(U_i)$	CONTINUE	SMOOTH-SHIFT
$Cb(U_i) \neq$ $Cp(U_i)$	RETAIN	ROUGH-SHIFT

Table 1: Transition Types

The theory also proposes two rules, violations of which are predicted to increase the hearer's inference load for the interpreting the discourse segment.

Rules: For each utterance, U_i , in a discourse segment $U_1, \dots, U_m$:

- 1 If some element of $Cf(U_{i-1})$ is realized as a pronoun in U_i , then so is the $Cb(U_i)$.
- 2 Transition sequences are ordered. CONTINUE > RETAIN > SMOOTH-SHIFT > ROUGH-SHIFT.

One indeterminate part of the theory is the manner in which the Cf -list is ranked. The ranking plays a crucial role as it determines which of the elements of $Cf(U_{i-1})$ realized in U_i will be the $Cb(U_i)$, upon which depends the calculation of the transitions across adjacent utterances and thus of the inference load for interpretation.

3 Relative Salience in Hindi

Crosslinguistic research within the framework of Centering theory has led to the speculation that languages may vary with respect to which linguistic properties affect the salience of discourse entities.³ For instance, Brennan

by U , or c is the interpretation of some subpart of U ; a center is *directly realized* if it corresponds to a phrase in an utterance (Grosz et al. 1995).

³For details on cross-linguistic research on Centering, see Sidner (1979), Gordon et al. (1993), Grosz et al. (1995) for English; Di Eugenio (1998) for Italian; Prince

et al. (1987) assume the following ranking for the *Cf*-list in English: *subject* > *object* > *object2* > *other subcategorized functions* > *adjuncts*. Walker et al. (1994) extend the *Cf*-ranking criteria for Japanese in order to account for zero-pronouns, topic-marked NPs and NPs which are emphasized by empathy-marked verbs. They propose the following ranking for Japanese: *topic (grammatical/zero)* > *empathy* > *subject* > *object* > *other(s)*. Rambow (1993) and Strube and Hahn (1999) suggest that the ranking in German might follow the *surface order position*. Gordon et al. (1993) suggest that *sentence-initial position* seems to contribute to salience. Turan (1995) argues that the *Cf*-list ranking in Turkish is associated with either *grammatical relation* or a *semantic role* hierarchy, and also provides evidence to show that word order does not play a role. Strube and Hahn (1999) propose that the ranking criteria for the *Cf*-list in German is partly determined by the information status of the discourse entities. They distinguish between *old*, *mediated*, and *new* discourse entities, and propose the following ranking: *old* > *mediated* > *new*.⁴

In the following section, we present a novel, general method for determining which aspects of linguistic knowledge play a role in ranking the elements of the *Cf*-list. We apply this method to Hindi and discuss the influence of grammatical function, word order, and information status.⁵

3.1 Method for Determining Relative Salience

Our method for determining relative salience invokes Rule 1 of Centering theory.⁶ According to this rule, if anything is pronominalized in an utterance, the *Cb* must be, too. In other words, if there is a single pronoun in an utterance U_i , it must be the *Cb* of U_i and it must cospecify with the highest ranked entity among those in U_{i-1} that are realized in U_i .⁷

(1994) for Yiddish; Kameyama (1985), Walker et al. (1994) for Japanese; Hoffman (1998), Turan (1995) for Turkish; Rambow (1993), Strube and Hahn (1999) for German; and Dimitriadis (1996) for Greek.

⁴The information status distinctions in Strube and Hahn (1999) correspond to Prince's (1981) distinctions in the following manner: *old* entities correspond to *unused* and *evoked* entities, *new* entities correspond to *brand-new* entities, and *mediated* entities correspond to *inferrables*, *containing inferrables* and *anchored brand-new* entities.

⁵In this paper, we ignore other factors that have been argued to affect *Cf*-list ranking, such as lexical semantics, intonation, tense etc..

⁶Rule 1 captures the intuition, originally stated in Sidner (1979, 1981), that pronominalization is one of the markers of salience (*immediate focus* in Sidner's terms).

⁷We assume that Rule 1 (as well as the other rules and constraints of Centering theory) has some cognitive reality (Gordon et al. 1993; Hudson-D'Zmura and Tanenhaus

We searched our corpus for utterance pairs, U_{i-1} and U_i , which satisfy the following three conditions:

1. U_i realizes *only two* of the entities from U_{i-1} .
2. In U_i , only one of the NPs realizing these entities is pronominalized.
3. The pronoun in U_i is ambiguous (for gender and number) between the two entities in U_{i-1} .⁸

The procedure for determining the relative salience of entities in any utterance U_{i-1} is as follows: given Rule 1 and the conditions stated above, if two discourse entities X and Y in U_{i-1} are both realized in U_i , with only Y being realized as a pronoun (in U_i), then Y must be the *Cb* of U_i and must cospecify with the highest ranked of all the entities in U_{i-1} that are realized in U_i . Since X and Y are the only two entities in U_{i-1} realized in U_i , Y must be ranked higher than X (or be more salient than X). Conversely, if it is X (and not Y) that is realized as a pronoun in U_i , then by the same reasoning X must be more salient than Y in U_{i-1} .

The method described above was applied to a corpus consisting of short stories. The 560 utterance pairs that filled the defined criteria were further categorized in different groups according to the linguistic properties of the NPs, such as grammatical function, word order and information status. Within each of these groups, further subgroupings were done according to the pair of factors that were being compared for relative salience. For example, one such grouping was in terms of grammatical function, and this had further subgroups—one for comparing the salience of subjects and direct objects, another for comparing the salience of direct objects and indirect objects, and so on.

Note, however, that Rule 1 is *not* non-violable. In fact, the calculation of discourse coherence in Centering theory is partly based on the assumption that speakers can be expected to violate Rule 1. However, for the task of determining relative salience according to our method, such an expectation seems to create the following *determinacy* problem. Consider any group of n utterance pairs, U_{i-1} and U_i ; such that two entities X and Y in U_{i-1} in all pairs exhibit the linguistic properties characterizing the group, with X having the property LX and Y having the property LY . As was described above,

1998).

⁸We selected utterance pairs with ambiguous pronouns to reduce the noise resulting from Rule 1 violations that are induced by the availability of grammatical information that allows inferential (defeasible) reasoning on the part of the hearer.

both these entities are realized in U_i in all pairs with only one of them being realized as a pronoun. Now, if all the n pairs in the group pronominalize the entity with the same property, i.e., either LX or LY , then the relative salience of the entities X and Y in U_{i-1} is completely determinate. However, if k pairs pronominalize the entity with property LX and $n - k$ pairs pronominalize the entity with property LY , then the analyst faces the question of deciding which one of the sets of pairs is the true indicator of salience. These two opposing cases are illustrated in the schematic diagram in Figure 1, where U_{i-1} and U_i are adjacent utterances, W, X, Y , and Z are the discourse entities in U_{i-1} , and A, B, X , and Y are the discourse entities in U_i . Both cases realize only two entities from U_{i-1} in U_i , namely X and Y , and X and Y in U_{i-1} have either the linguistic property LX or LY . In U_i in Case 1, Y is realized as a pronoun (labeled 'pro') and X as a full noun phrase (labeled 'NP'), whereas Case 2 shows the opposite situation. The task, therefore, is to decide which of

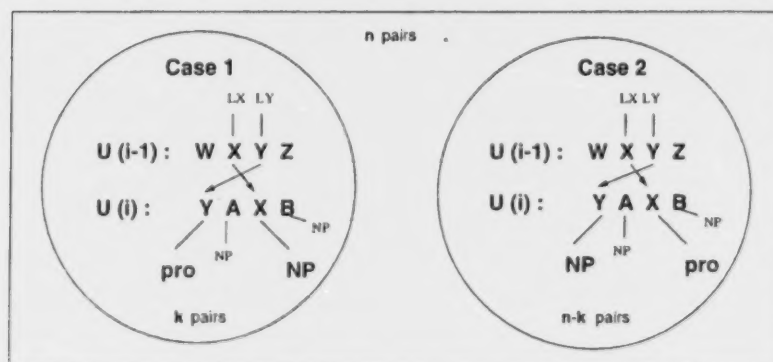


Figure 1: Opposing behaviors for Salience

the cases is a true indicator of relative salience and which constitutes a Rule 1 violation. Our decision is based on frequency of occurrence of the two cases in the corpus, in that the one which occurs with greater frequency is taken to be the indicator of salience. This is motivated by the assumption that speakers exhibit a preference for adhering to Rule 1 and that this preference can be observed in naturally occurring discourse in terms of greater (given that the opposing case does occur at all) frequencies of occurrence (Jaspars and Kameyama 1995). As will be seen later, this assumption is empirically justified in our corpus.

3.2 Some Facts about Hindi

Before proceeding with the investigation of the factors determining relative salience in Hindi, a few remarks about the language are in order. The subject-indirect object-direct object-verb (S-IO-DO-V) order is the default word order in Hindi. However, the language allows many other word orders (example (1)) which signal distinctions in meaning (Gambhir 1981) relating to information structure (Vallduví 1990). Hindi has a rich case system, though case marking is not obligatory. Pronouns are unmarked for gender and only partially marked for number.⁹ In particular, though some forms, like *usne* 'he', *usko* 'him', are unambiguously singular, some forms can be both singular and plural, like *unhone* 'he/they', or *unko* 'him/them'.

- (1) a. *malay-ne sameer-ko kitaab dii* (S-IO-DO-V)
 malay-ERG sameer-DAT book-ACC gave
 'Malay gave the book to Sameer'
 b. *malay-ne kitaab sameer-ko dii* (S-DO-IO-V)
 c. *sameer-ko malay-ne kitaab dii* (IO-S-DO-V)
 d. *sameer-ko kitaab malay-ne dii* (IO-DO-S-V)
 e. *kitaab malay-ne sameer-ko dii* (DO-S-IO-V)
 f. *kitaab sameer-ko malay-ne dii* (DO-IO-S-V)

Hindi has verb agreement with the subject or the direct object. The agreement inflection is marked for person, number, and gender. With respect to the form and information status of noun phrases, Hindi has (non-obligatory) definite and (obligatory) indefinite articles. Following Prince (1992), the NPs with the indefinite article usually refer to hearer-new and discourse-new entities, whereas NPs with the null/overt definite article usually refer to hearer-old and/or discourse-old entities.

3.3 Factors Determining the Ranking

In all the examples in this section, the pronouns and the NPs they cospecify with are indicated in boldface and by coindexation.¹⁰ In each case, the pronoun is ambiguous with respect to the person, number or gender features of

⁹Hindi also has zero pronouns, but their occurrence is heavily constrained, unlike in Italian (Jaeggli and Safir 1989) or Japanese (Kameyama 1985). In this paper, we do not investigate the interpretation of null pronouns in Hindi.

¹⁰To avoid confusion between the ambiguous denotation of the Hindi pronouns and the unambiguous English translations, the pronouns are glossed as *pro*.

the two entities whose salience is being compared (and which are indicated by square brackets with grammatical category labels).¹¹

3.3.1 Grammatical Function: Subject vs. Direct Object/Indirect Object

Example (2) illustrates that the subject is ranked higher than the direct object. Both the subject and direct object in (2a) are realized in (2b), but it is the subject that is realized as the pronoun. The subject, therefore, qualifies as the *Cb* of (2b) and consequently as the more highly ranked of the two entities in (2a) that are realized in (2b).

- (2) a. aise maukoN par [*S savaariyaan*]_i [*DO chaate*]_j taan letii
 such occasions on [*S passengers*]_i [*DO umbrellas*]_j open take
 haiN
 3pl.fem.prs
 'On such occasions the passengers open umbrellas'
- b. kabhi-kabhi tej havaa se [*chaate*]_j [*unke*]_i haath
 sometimes fast wind with [*umbrellas*]_j [*pro-POSS*]_i hands
 se urr bhii jaate haiN
 from fly also go 3pl.fem.prs
 'Sometimes, because of the strong winds, the umbrellas even fly away from their hands'

By the same argument, example (3) shows that the subject is ranked higher than the object within the prepositional argument of the verb. Both the subject as well as the prepositional object in (3a) are realized in (3b), but it is the subject that is pronominalized and therefore, it qualifies as the *Cb* of (3b) and as more highly ranked than the prepositional object in (3a).

- (3) a. kuch der pashchaat, [*S ek shramik*]_i [*PP [PO us yuvak]*]_j
 some time after, [*S a laborer*]_i [*PP [PO that youth]*]_j
 ke paas] aayaa
 near to] came
 'After some time, a laborer came up to the youth'
- b. [*usne*]_i [*yuvak*]_j se puuchaa ki "kyaa aagyaa hai?"
 [*pro-ERG*]_i [*youth*]_j of asked that "what wish is?"
 'He asked the youth, "what is your wish?"'

¹¹S = subject, DO = direct object, IO = indirect object, PP = prepositional phrase, PO = prepositional object, ACC = accusative, ERG = ergative, DAT = dative.

334 utterance pairs in the corpus consisted of the subject and either the direct object, or the indirect object, or the prepositional complement being realized in both the utterances in the pair (see Table 2). 322 cases show the subject ranked higher (in particular, out of 149 pairs for comparing the subject and the direct object, 144 have the subject realized as a pronoun in the second utterance (96%) and 5 have the direct object as the pronoun (4%); out of 57 pairs for comparing the subject and the indirect object, 50 have the subject realized as a pronoun (87%) and 7 have the indirect object realized as the pronoun (13%); finally, out of 128 pairs for comparing the subject and the prepositional complement, all have the subject realized as the pronoun (100%)).

3.3.2 Grammatical Function: Direct Object vs. Indirect Object

Examples like (4) suggest that a higher degree of salience is attributed to entities denoted by the direct object when compared to indirect objects. Both the direct object and indirect object in (4a) are realized in (4b), but it is the direct object that is pronominalized. Note that the pronoun in (4b) is unmarked for gender and number and is therefore ambiguous between the two antecedents in (4a) (DO is masculine and IO is feminine).

- (4) a. [_S dukaandaar ne]_i [_{DO} **kaii namune ke kapDe**]_j [_{IO} un
[_S shopkeeper ERG]_i [_{DO} **many types of clothes**]_j [_{IO} those
striiyon ko]_k dikhaaye
women ACC]_k show-3sg.m.pst
'The shopkeeper showed many types of clothes to those women'
- b. [un striiyon ko]_k [**unme**]_j se kuch pasand aaye
[those women ACC]_k [**pro**]_j of some like come-3pl.pst
aur kuch unhone alag hataa diyaa
and some they-ERG aside remove give.3sg.pst
'The women liked some of them and some they removed aside'

The corpus contains 22 pairs illustrating the comparison above (see Table 2), and all of them have the direct object realized as the pronoun in the second utterance.

Other ranking comparisons constitute the rest of the pairs in the corpus, i.e., 204 pairs (see Table 2 for detailed figures). The partial ranking with respect to the grammatical functions that we were able to investigate can thus be specified as follows: *subject* > *direct object* > *indirect object/PP object* > *adjuncts*. In addition, we also specify that for a possessive noun phrase, *possessor* > *head noun*.

Ranking	Number	Total	Frequency
Subject > Direct Object	144	149	96
Subject > Indirect Object	50	57	87
Subject > PP Object	128	128	100
Direct Object > Indirect/PP Object	22	22	100
Subject/Object > Adjunct	96	110	87
Possessor > Head	22	22	100
Subject > Possessor of Direct Object	50	50	100
Indirect Object > Possessor of Subject	22	22	100
Total	534	560	95

Table 2: Frequencies for Relative Saliency of Grammatical Functions

3.3.3 Against Word Order and Information Status

The surface order of constituents has been argued to be a determining factor for relative saliency in German (Rambow 1993; Strube and Hahn 1999). Our Hindi corpus does contain utterance pairs in which the entity represented by the sentence-initial constituent is found to be the *Cb* in the next utterance, but in fact, these constituents are always the subject. Furthermore, there are also cases in which the subject occurs in some non sentence-initial position, and examples such as (5a-b) show that it is the subject, rather than the sentence-initial constituent occurring in the initial position, which is realized as the *Cb* in the following utterance.

- (5) a. [_{PO} *bailon*]_i ke biich [_S *ek purush*]_j kharaa hai
 [_{PO} *buffalos*]_i of between [_S *a man*]_j stand.3sg 3sg.pres
 'There is a man standing between the buffalos'
- b. [*vah*]_j [_{IO} in *bailon ko*]_i charaa daal rahaa hai
 [*he*]_j [_{IO} these buffalos DAT]_i fodder put do.3sg 3sg.pres
 'He is giving fodder to these buffalos'

In the transition from (5a) to (5b), the subject is not in sentence-initial position in (5a), but still denotes the centered entity, since it is the antecedent of the pronoun, the *Cb*, in (5b). The example also shows that unlike German, the information status of discourse entities does not play a role in the *Cf*-list ranking in Hindi. In (5a), a new entity, *ek purush*, 'a man' is introduced, and the utterance also contains a discourse old entity, *bailon*, 'buffalos'. Ranking the entities according to the criteria suggested for German (with *old* > *mediated* > *new* (Strube and Hahn 1999)) cannot account for the realization of

the discourse new entity, *a man*, as a pronoun, the *Cb*, in (5b). What really matters is that the discourse new entity is found to be in the subject position of the sentence. In all such cases, where some NP denoting a discourse-old entity is preposed to the sentence-initial position, it is the discourse new entity in subject position that is pronominalized in the following utterance.

In conclusion, the corpus revealed an overwhelming influence of grammatical function on the salience of the discourse entities evoked in an utterance, and therefore of the *Cf*-list in Centering terms. Furthermore, word order and information status do not seem to play any independent role in determining relative salience in Hindi.

4 The BFP Algorithm

In this section, we apply the BFP algorithm for pronoun resolution in Hindi using the ranking obtained in the previous section. The algorithm described by Brennan et al. (1987) incorporates the centering rules and transitions and consists of three basic steps (as described by Walker et al. (1994)).¹²

1. GENERATE possible *Cb-Cf* combinations (anchors).
2. FILTER by constraints, e.g., contra-indexing, sortal predicates, centering rules and constraints.¹³
3. RANK by transition orderings.

In applying the BFP algorithm, we found that the algorithm makes two types of strategic errors. The first is caused by its preference for *Continue* transitions. This preference implies that a pronoun in U_i is more likely to refer to the $Cb(U_{i-1})$ than to the $Cp(U_{i-1})$ when $Cb(U_{i-1}) \neq Cp(U_{i-1})$ (= *Retain* or *Rough-shift*). This preference does not hold for Hindi, as shown in example (6).¹⁴ The tables below each utterance contain the filtered anchors for that utterance. The second column in the tables represents the discourse entities and the third column represents the corresponding surface expressions.

- (6) a. Congress adhyaksh₁ unse₂ aise mile
 Congress director₁ him₂-with this-way met
 'The Congress director met him in such a way,'

¹²The algorithm has also been applied to Japanese by Walker et al. (1994).

¹³Contra-indexing constraints on coreference originate from Binding theory (Chomsky 1981).

¹⁴From "Bihari Babu ke haseen sapne". Article in *India Today*. Issue: 31 December 1997.

(i)	Cb :	Laalu : (2)	<i>unse</i>
	Cf :	[Director (1) :	<i>Congres adhyaksh</i>
		Laalu (2) :	<i>unse</i>]
	Tr :	Retain	

Table 3: Analysis for (6a)

- b. jaise $ve_{1/\#2}$ apnii partii₃ ke taaranhaar kaa svaagat kar rahe
 as-if he_{1/\#2} SELF party₃ of best-man of reception doing was
 hon
 be-subjunc.
 'as if he was receiving the best man of his party.'

(i)	Cb :	Director (1):	<i>ve</i>	(ii)	Cb :	Laalu (2) :	<i>ve</i>
	Cf :	[Director (1) :	<i>ve</i>		Cf :	[Laalu (2) :	<i>ve</i>
		party (3) :	<i>partii]</i>			party (3) :	<i>partii]</i>
	Tr :	Sm-Shift			Tr :	Continue	
		Preferred				Dispreferred	

Table 4: Analysis for (6b)

(6a) has a Retain transition, where the pronoun *unse* (which refers to a man called Laalu mentioned in the utterance before (6a)) is the *Cb*. In (6b), the pronoun *ve* can refer to both *Congress director* and *Laalu*, and Step 2 of the BFP algorithm yields a Smooth-shift and a Continue for these two anchors, shown in tables 3 and 4. Step 3 of the BFP algorithm would then rank the *Continue* transition above the *Smooth-Shift*, thus assigning *Laalu* as the antecedent for the pronoun. However, it is the *Smooth-shift* transition which gives the correct and more natural interpretation.¹⁵ Since the use of Rule 2 in the BFP algorithm does not capture the clear preference for the $Cp(U_{i-1})$ in such cases, we propose that the BFP algorithm should be reduced to a simple look-up in the *Cf*-list, the order of which gives the preference for the antecedents of pronouns. This, as will be shown in the next section, is possible with the S-list algorithm since it does not use the centering transitions to compute the antecedents for the pronouns.

¹⁵The Smooth-shift transition would have been obtained even if the pronoun had been zero instead of overt. This is different from what has been said about Italian by Di Eugenio (1998). In Italian, a Smooth-shift or a Retain is preferred with overt pronouns, but a Continue transition is preferred with null pronouns.

The second type of error generates ambiguities for U_i when the following two conditions hold:

1. (a) when the $Cb(U_{i-1})$ is undefined (after segment boundaries and after intervening utterances without anaphoric relationships to the immediately previous context), or
 (b) when the pronoun under consideration cannot co-specify the $Cb(U_{i-1})$, and
2. U_i contains a pronoun (with features not identical to any other pronoun in U_i) which has more than one possible antecedent in $Cf(U_{i-1})$.

Under these conditions the algorithm generates ambiguous readings with the same transition and which cannot be disambiguated by Step 3 of the BFP algorithm. This leads to an ambiguity, and possibly an error chain that could continue throughout the discourse segment and beyond. Condition (1a), where the $Cb(U_{i-1})$ is undefined, is illustrated in example (7).¹⁶ Though the example is from Hindi, such ambiguities would be generated for any language (provided the conditions described in (1) and (2) above hold).

- (7) a. B.Singh₁ apni₁ aadhi se adhik sampatti₂ vakilon₃ ko bhent
 B.Singh₁ his₁ half than more wealth₂ lawyers₃ to present
 kar chuke the
 do perf. had.
 'B.SiNgh had presented more than half of his wealth to lawyers.'

(i)	Cb : none	
	Cf : [BS (1) :	<i>B.Singh</i>
	Wealth (2) :	<i>sampatti</i>
	Lawyers (3) :	<i>vakiilon</i>
	Tr : none	

Table 5: Analysis for (7a)

- b. unki_{1/3} vartamaan aaya₄ ek hazaar rupaye₅ vaarshik
 his₁/their₃ present salary₄ one thousand rupees₅ annually
 se adhik na thii.
 than more not was.
 'His/Their current salary was not more than one thousand rupees annually.'

¹⁶From "Bare Ghar kii Betii". Short story in *Premchand: Pratinidhi kahaaniyaan*. 1987, p.62.

(i)	Cb :	BS (1):	<i>unki</i>	(ii)	Cb :	Lawyers (3) :	<i>unki</i>
	Cf :	[BS (1) :	<i>unki</i>		Cf :	[Lawyers (3) :	<i>unki</i>
		Salary (4) :	<i>aayaa</i>			Salary (4) :	<i>aayaa</i>
		Rupees (5) :	<i>rupaye]</i>			Rupees (5) :	<i>rupaye]</i>
	Tr :	Continue			Tr :	Continue	

Table 6: Analysis for (7b)

The analysis for the utterances is provided below the examples. (7a) has no *Cb* and its *Cf*-list has three elements. (7b) contains one pronoun, *unki*. Step 1 of the BFP algorithm generates three anchors for each element of the *Cf*(7a)-list. Step 2 eliminates *wealth* as a possible antecedent because it does not pass the filter (*wealth* is singular whereas the pronoun *unki* is plural/honorific). *BS* and *lawyers* pass the filter since the former is honorific and the latter plural. These two anchors, with *BS* and *lawyers* resolved to the pronoun, are shown in 7b(i) and 7b(ii). Now, Step 3 is applied to rank the transitions for these anchors. However, this cannot be done since both the transitions are Continue (*Cb*(7a) is undefined, and *Cb*(7b) = *Cp*(7b)). Inability to rank the two must leave the pronoun resolved to both *BS* and *lawyers*, thus creating an ambiguity. Cases such as these suggest that the ambiguities are generated because of the use of the *Cb* for the computation of pronominal antecedents. We note again that the antecedent can be correctly selected by a simple look-up in the *Cf*-list, as is done in the S-list algorithm.

5 The S-list Algorithm

The S-list algorithm (Strube 1998) is based on a model which consists of a single construct, called the S-list, and one operation, the insertion operation. The model is designed to be applied incrementally and describes the attentional state of the hearer at any point in the discourse. The S-list contains some discourse entities which are realized in the current as well as the previous utterance. A ranking is imposed on the elements of the S-list, being determined by information status and/or word order (Strube and Hahn 1999), and the order among the elements provides straightforward preferences for the antecedents of pronominal expressions. However, in Hindi, as we hope to have shown conclusively in Section 3, information status or word order do not seem to affect the salience of discourse entities. Based on our results, we propose the following conventions for ranking the S-list elements in Hindi: the 3-tuple (x, utt_x, gr_x) denotes a discourse entity x which is *evoked* in ut-

terance utt_x with the grammatical role gr_x . With respect to any two discourse entities (x, utt_x, gr_x) and (y, utt_y, gr_y) , with utt_x and utt_y specifying the current utterance U_i or the preceding utterance U_{i-1} , we set up the following ordering constraints on elements in the S-list (Table 7).¹⁷

- (1) If $gr_x > gr_y$, then $x < y$.
- (2) If $gr_x = gr_y$
then if utt_x follows utt_y , then $x < y$,
if $utt_x = utt_y$ and pos_x precedes pos_y , then $x < y$.

Table 7: Ranking Constraints on the S-list

The algorithm proposed in Strube (1998) together with the language specific ordering constraints proposed for Hindi resolves the pronouns by a simple look-up in the S-list, and the elements are tested in the given order until one test succeeds. The algorithm (taken from Strube 1998) is given as follows:

1. If a referring expression is encountered,
 - (a) if it is a pronoun, test the elements of the S-list in the given order until the test succeeds;¹⁸
 - (b) update S-list; the position of the referring expression under consideration is determined by the S-list-ranking criteria which are used as an insertion algorithm.
2. If the analysis of utterance U is finished, remove all discourse entities from the S-list, which are not *realized* in U .

6 Empirical Data

In this section, we present the results of the application of the BFP algorithm and the S-list algorithm to pronoun resolution in Hindi texts. We used the following guidelines for our tests (see Walker 1989). The basic unit for which the centering data structures are generated is the utterance. The utterance U

¹⁷The relation $<$ between two entities x and y denotes their relative ordering in the S-list. The relations $>$ and $=$ between gr_x and gr_y indicate that the grammatical role of x is higher than that of y in the ranking hierarchy or that the grammatical roles of x and y are the same.

¹⁸Testing the elements of the S-list involves checking for agreement features, coreference restrictions and sortal constraints.

is defined as a sentence. Coordinated clauses are taken as separate utterances. A segment is defined as a paragraph unless its first sentence has a pronoun in subject position or a pronoun where none of the preceding sentence-internal noun phrases matches its syntactic features (cf. Walker 1989).

According to the preference for inter-sentential candidates in Centering theory, we defined the following anaphora resolution strategy for the BFP algorithm (at the beginning of a discourse segment the order of steps 1 and 2 is reversed):

1. (a) test elements of $Cf(U_{i-1})$,
2. (b) test elements of U_i left-to-right,
3. (c) test elements of $Cf(U_{i-2})$, $Cf(U_{i-3})$, ...

6.1 Analysis and Results

For our evaluation of the two algorithms, we analyzed some Hindi texts.¹⁹ The results of our analysis are given in Table 8. The first two rows give the number of utterances in the test set and the number of pronouns. The remainder of the table is divided into two parts, each containing results for the two algorithms, respectively. For each algorithm, the numbers of correct and incorrect resolutions are given in the rows marked *correct* and *wrong*. The wrong resolutions are further broken up by the type of error and are described as follows:

- *wrong (strategic)* means that the errors are directly produced by the strategy of the algorithm;
- *wrong (ambiguity)* gives the number of ambiguous analyses;
- *wrong (intra-sentential)* means that the errors are caused by unspecified preferences for intra-sentential antecedents;
- *wrong (chain)* means that the errors were caused by error chains;
- *wrong (other)* gives the remaining errors (for example, errors relating to missing specifications for anaphora across segment boundaries).

¹⁹The test set consisted of two short stories by Indian novelists, Munshi Premchand and Usha Priyamvada, and one article from a news magazine, *India Today*.

		Prem	Vaap	IT	Total
Utterances		57	139	71	267
Pronouns		41	100	45	186
BFP Alg.	Correct	18	79	38	135
	Wrong	23	21	7	51
	Wrong (strategic)	6	5	3	14
	Wrong (ambiguity)	5	2	1	8
	Wrong (intra-sentential)	3	4	1	8
	Wrong (other)	3	5	0	8
	Wrong (chain)	6	5	2	13
S-list Alg.	Correct	34	88	44	166
	Wrong	7	12	1	20
	Wrong (strategic)	2	1	1	4
	Wrong (other)	3	5	0	8
	Wrong (chain)	2	6	0	8

Table 8: Results of the BFP and S-list Algorithm

6.2 Evaluation

The *wrong (other)* errors for both algorithms were caused by underspecification for the definition of the discourse segment. In other words, the pronouns were found to select an antecedent too far back in the discourse.²⁰ The table shows that the BFP algorithm generates errors due to ambiguities (*wrong (ambiguity)*). This is because the algorithm implements the model by comparing possible transitions, which results in inevitable ambiguities in the two types of cases discussed in Section 4. The S-list algorithm, on the other hand, does not generate any ambiguities because of its simple look-up in the S-list for the first possible antecedent match. The BFP algorithm also generates errors due to unspecified preferences for intra-sentential anaphora (*wrong (intra-sentential)*), which are not found in the application of the S-list algorithm because it integrates preferences for inter- and intra-sentential anaphora by making the S-list span across multiple utterances, the current and the previous.

To summarize, our results show (confirming Strube's (1998) results) that the S-list algorithm performs better than the BFP algorithm in general. In particular, we have illustrated that, for a language like Hindi, in which the

²⁰We do not pursue this issue here, primarily because of the absence of any precise and implementable definition of the discourse segment (but see Grosz and Sidner (1986)).

ranking is determined by grammatical role and not by information status or word order, the algorithm can be applied straightforwardly if the S-list ranking is made language-specific.

7 Conclusions

In this paper, we proposed a novel method for determining the relative salience in discourse entities and applied this method to Hindi. We concluded that the *Cf*-list ranking in Hindi is crucially determined by *grammatical role*, and that information status and word order do not have any independent effect on salience. We also applied the proposed ranking to two pronoun resolution algorithms, the BFP algorithm and the S-list algorithm, both of which use the notion of the *Cf*-list for computing pronominal antecedents, and showed that better results are obtained with an algorithm that does not make straightforward use of the Centering notions of the *Cb* and the transitions.

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The Effect of Thematic Roles on Pronoun Use and Frequency of Reference Continuation*

Jennifer E. Arnold

1 Introduction

Research has shown that pronoun resolution is influenced by the thematic roles of discourse referents (e.g., Garnham et al. 1996, Garvey and Caramazza 1974, McDonald and MacWhinney 1995, Stevenson et al. 1994). For example, the pronouns in (1a) and (b) are more naturally interpreted as co-referential with the stimulus referent—i.e., the entity that occurs in the stimulus role in the first clause, in this case, John.

- | | | | | |
|--------|-------------|---------|-------------|---------------|
| (1) a. | <u>John</u> | amazed | <u>Bill</u> | because he... |
| | stimulus | | experiencer | |
| b. | <u>Bill</u> | admired | <u>John</u> | because he... |
| | experiencer | | stimulus | |

This bias toward John has been attributed to the 'Implicit Causality' of the verb. That is, John is implicitly understood at the cause of the event denoted by the verb (e.g., Au 1986, Brown and Fish 1983), which influences the interpretation of the ambiguous pronoun he.

There are several questions that arise from this line of research. First, does the same factor influence the speaker's choices in reference form? Evidence suggests that it would: off-line data from a sentence-completion study shows that thematic roles influence choices in referring forms in writing (Stevenson et al. 1994), and pronoun use is generally influenced by the same factors as pronoun comprehension (Arnold 1998). In this paper I will focus on goal and source roles in verbs of transfer, like *give* or *receive*, and confirm that speakers use pronouns for subsequent reference to goal entities more often than for source entities.

More important is the second question: Why do thematic roles influence referent accessibility in the way they do? Previous research on implicit cau-

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salinity and thematic role biases have left this question relatively unanswered. Most researchers have accounted for pronoun biases in sentences like (1) in terms of readers' interpretations of the implicit cause of the event (e.g., Garvey and Caramazza 1974, McDonald and MacWhinney 1995). However, implicit causality only impacts pronoun resolution when the following clause is introduced with a *because* connector. Therefore, an implicit causality account is not a general explanation.

Stevenson et al. (1994) provide a more sophisticated account of thematic role biases, suggesting that with verbs that denote events, readers by default focus on the consequence of the event, but with stative verbs (that have no event structure), readers by default focus on the cause. In addition, these biases can be enhanced or reversed in the presence of connectors like *because* or *so*. However, a limitation of this account is that it depends on a set of rules for specific verbs or verb classes, e.g., "focus on the consequences unless you see the connector *because*." Furthermore, it suggests that referent accessibility is driven by default processing assumptions, which would suggest that processing preferences are relatively homogeneous. By contrast, I will present results that are not consistent with an account driven by defaults.

In this paper I will build on Stevenson et al.'s account, proposing a more general explanation of how and why thematic role information influences referent accessibility. I will present results from a story-continuation experiment and a corpus analysis which suggest that the bias towards goals is linked to a more general tendency for speakers to frequently refer to goal entities.

2 Goal and Source in Verbs of Transfer

The studies in this paper investigate goal and source roles in transfer verbs. These verbs are advantageous because there are some verbs in which the subject is the source (e.g., *send*) and some verbs in which the subject is the goal (e.g., *receive*). This feature is important because research has shown that reference form is highly sensitive to the grammatical role of the antecedent (e.g., Arnold 1999, Gordon et al. 1993, Stevenson et al. 1994). Therefore, the effect of other characteristics such as thematic roles may only be observable while controlling for grammatical role.

In this study I am concerned with how referent accessibility is influenced by the thematic roles played by discourse entities in the preceding discourse. Therefore, I am interested in how speakers choose referring forms for entities that were the goal or the source of the preceding clause. To refer to these entities, I will use the terms 'goal-referent' or 'source-referent.' Similarly, I will use the terms 'subject-referent' or 'object-of-PP-referent' to refer to those same entities in terms of the grammatical function of the last phrase used to refer to them.

Past research suggests that goal-referents are more accessible than source-referents (Stevenson et al. 1994, Stevenson and Urbanowicz 1995, Wilson and Stevenson 1999). The participants in Stevenson et al.'s (1994) sentence-completion study interpreted ambiguous pronouns as referring to goal-referents more often than to source-referents, and in the condition where the pronoun was not supplied, participants referred to the goal more than to the source. Wilson and Stevenson (1998) replicated these findings, and also showed that pronouns referring to goal entities are read faster than pronouns referring to source entities.

Further support comes from Stevenson and Urbanowicz's (1995) self-paced reading experiment, in which they recorded the time it took participants to read anaphors with goal- or source-referents. Although their discussion did not focus on the difference in reading times for pronouns and full names, their results can be used to investigate whether names are read faster than pronouns, and if so, whether this difference varies depending on the thematic role of the antecedent. Using their data, I calculated the difference between the reading times for pronouns and names ($= (\text{average RT for pronouns}) - (\text{average RT for names})$), such that a positive difference indicates a shorter reading time for names. Figure 1 presents the average differences in reading times separately for NP1 antecedents (subject antecedents) and NP2 antecedents (object antecedents).

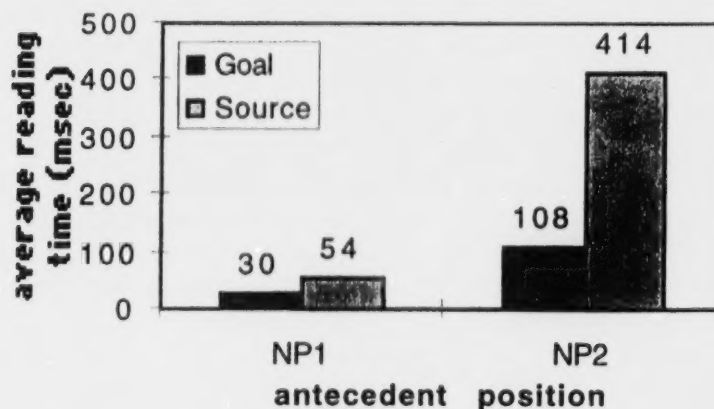


Figure 1. The extent to which reading times were shorter for names than pronouns, in msec. (Calculated from data in tables (2) and (4), Stevenson and Urbanowicz 1995).

These data show that participants read names faster than pronouns in all conditions, which could be termed a 'name advantage.' However, there was a greater name advantage for source-referents than goal-referents, for both NP1

and NP2 antecedents. Put another way, pronouns were read relatively faster for goal-referents than source-referents, suggesting that the goal-referent was more accessible. At the same time, thematic role interacted with order of mention, such that the advantage for goal referents was stronger for object-of-PP-referents.

Thus, there is good reason to think that goal-referents are more accessible than source-referents, at least at the moment that referring forms are encountered. But why does this pattern exist?

I performed the experiment described below to investigate two questions. First, are speakers' on-line choices of referring forms indeed influenced by thematic role? Second, can the effects of thematic roles be explained in terms of more general patterns of reference continuation? That is, do speakers tend to continue talking about goal- or source entities more frequently?

3 Experiment: Goals and Sources

3.1 Method

The methodology used in this experiment was an oral story-continuation, conducted in the language laboratory at Stanford University. Each participant sat in a cubicle outfitted with a tape recorder and headset with a microphone and earphones. The stimuli were provided in written form, with several spaces between each item to prevent participants from reading the following item while completing the current one. The first two sentences in each stimulus item set the context for the story; the last sentence contained a verb with goal and source arguments. Examples are in (2) and (3).

- (2) There was so much food for Thanksgiving, we didn't even eat half of it. Everyone got to take some food home. Lisa gave the leftover pie to Brendan. . . .
- (3) I hate getting sick. It always seems like everyone gets sick as soon as it's vacation. Marguerite caught a cold from Eduardo two days before Christmas. . . .

Participants were asked to read these stories aloud into a tape recorder and add a natural continuation sentence to the story at the end.

This method combines comprehension and production processes. Although the task was to produce an utterance, it required participants to comprehend the stories before providing a continuation. Of particular importance is that their responses were made on the basis of the mental representations they developed while reading the story. In that sense, their

responses reflect the accessibility of discourse entities that resulted from their comprehension of the story.

This method allowed me to investigate several things. First, participants were not restricted in the type of continuation they added, except that it had to be a new sentence, rather than a continuation of the last one. This freedom meant that their responses provided information about how they would tend to continue the story, and allowed me to investigate which character they would mention first. Second, I could analyze whether participants used pronouns more often for goal or source characters.

A third question that I asked in this study was how the participants' continuations would be influenced by the relationship between their continuation sentence and the stimulus story. That is, did participants produce continuations that expressed the cause of the preceding event, a subsequent event, or something else? I considered the participants' continuation to be an indicator of their mental representation as it was at the end of the stimulus story. Therefore, if a participant provided a causal continuation, it signaled that the causal relationship was most activated at the end of the stimulus story.

The method I used had other advantages as well. Since the task was oral, rather than written, it reflected on-line processes. In contrast, a written story-continuation methodology would have allowed participants to reflect upon the story and their continuations. Also, in contrast with rating questionnaires, this method makes it possible to exclude an item when it was clear that the participant had not understood the story as intended (for example, when a name was interpreted with a different gender than the one intended).

3.2 Materials

Each stimulus item consisted of a three-sentence story like (2) and (3) above. The first two sentences provided the context, and did not contain individual references to either of the characters introduced in the third sentence. The third sentence included either a goal-source verb or a source-goal verb; all the verbs used are provided in (4).

(4) Verbs used in the story-continuation experiment

- a. Source-Goal verbs: bring, give, hand, loan, offer, pass, pay, rent, sell, send, show, teach (used twice), tell, throw, toss
- b. Goal-Source verbs: accept, borrow, bought, catch (used twice), get (used twice), grab, hear, inherit, learn, purchase, receive, rent, snatch, take

All verbs were used in a prepositional frame. Source-goal verbs are commonly used in both prepositional and double-object constructions ('Cynthia taught the lambada to Sean' / 'Cynthia taught Sean the lambada'). For these verbs I only included prepositional constructions. This was to maintain consistency with the goal-source verbs, where the source argument must appear as an object of preposition, as in 'Annette caught a ride from Scott'. This consistency was particularly important because the choice between the double object and prepositional constructions is partly driven by the discourse status of the referents (Arnold et al., in press).

In the third sentence of each story, two human characters were introduced by first names. These two characters filled the source and goal roles in the event. The names used were ones that are almost always associated with only one gender. In all cases, the two characters were of opposite gender. The theme argument was always inanimate. In half the items, the theme argument occurred as a definite NP, in half as an indefinite NP.

Unlike other implicit causality studies, I did not include any conditions with overt connectors like *because* or *so*. Their absence meant that the relation of the continuation sentences was driven by other factors. The purpose of this study was not to discover exactly what those were. Instead, I just wanted to know whether participants would choose to refer to source- or goal-referents more often, depending on the role of the continuation sentence.

A total of 16 sentences were constructed with each type of verb. Each participant saw all 32 items (Appendix A). They were combined with 24 items belonging to another experiment (Experiment 2 in Arnold 1999), such that items for each experiment served as distractors for the other. The items from the other experiment also had three sentences and used proper names, but followed a different structure from the current experimental items.

3.3 Participants

Sixteen native speakers of English from the Stanford community participated in this and another experiment in exchange for \$7. The approximate time needed to complete both experiments was forty-five minutes. *Native speaker* was defined as having started learning English by 5 years of age.

3.4 Results

The continuations for each item were tape-recorded and transcribed. Thirty-five continuations were excluded from the analysis. Reasons for exclusion included continuing the last sentence rather than beginning a new one ($n=13$), adding a nonsensical or ambiguous continuation ($n=6$), saying nothing at all ($n=3$), experimenter error ($n=8$), or interpreting the name of one of the characters with the unintended gender ($n=5$). For example, the name *Ali* was

intended as a female name, but some participants read the name *Ali* as a male name, with an accent on the second syllable. Examples of scorable participant continuations are shown in Table 1.

Stimulus: *There was so much food for Thanksgiving, we didn't even eat half of it. Everyone got to take some food home. Lisa gave the leftover pie to Brendan. . .*

- Brendan loved pie and cakes and all manner of sweet things but didn't know how to bake.
- He needed it the most since he was living off campus and didn't have access to food.
- I got the turkey and the stuffing, yum!
- She gave all the leftover turkey to me, and I asked if I could have the stuffings too, but she said don't be greedy, she gave the stuffings to her sister.

Stimulus: *I hate getting sick. It always seems like everyone gets sick as soon as it's vacation. Marguerite caught a cold from Eduardo two days before Christmas. . .*

- Unfortunately, Marguerite was sick on Christmas day.
 - She was headed for the Bahamas, and it was tough.
 - Eduardo gave it to me . . and so I was sick over the entire holiday.
 - And they were both in bed for the holiday.
-

Table 1. Example responses from the story-continuation experiment.

I was only interested in the frequency of referring to the goal and source characters, so references to other people or things were not included in the analysis. This left 346 continuations that could be analyzed.

For each item, I only considered the first continuation sentence, coding three things. First, I identified which character or object from the previous utterance was referred to first, if any. Second, I looked at how this character was referred to—with a pronoun or with a name. The rationale behind this procedure was to determine which of the two characters was considered more relevant to the following discourse, and to see how that character was referred to.

I also looked at a third factor: type of continuation sentence. I coded each response in terms of its contribution to the discourse: a) specifying the cause, b) specifying the consequence, c) elaborating or developing the idea of

the last sentence further, or d) describing a *related* yet independent fact or event. Table 2 shows examples of each type.

RELATION	EXAMPLE
cause	The U2 concert was sold out a week before the show. Scalpers were selling tickets for ridiculous prices. Fortunately Rafael got a ticket from Gabrielle. <i>Gabrielle's friend Phil couldn't make the concert.</i>
consequence	I hate getting sick. It always seems like everyone gets sick as soon as it's vacation. Marguerite caught a cold from Eduardo two days before Christmas. <i>It kind of put a damper on the Christmas festivities.</i>
elaboration	The professors in the music department were all in a good mood. The first day of music lessons had gone unexpectedly well. Melora taught a sonata to Mike in an hour and a half. <i>That is really fast.</i>
related	My physics class gets out at 7 pm and it's already dark then. A lot of people have trouble getting home. Annette usually catches a ride from Scott. <i>I was wondering if I should ask Scott to give me a ride also.</i>

Table 2. Examples for each category of relation between the continuation sentence and previous one. (Participant continuation is italicized).

The results were tabulated in terms of each question. First, in what percentage of cases did people refer to the source-referent, and in what percentage to the goal-referent? Second, what was the rate of pronoun use for each type of referent? Third, how was the choice to talk about the goal or the source influenced by the choice of how the continuation sentence would relate to the rest of the story? The significance of each result was tested with a stepwise logistic regression, using SPSS 6.1. The contribution of each factor is measured in terms of the ratio of the log likelihood of a model with that factor and a model without that factor. The models can be built using either a step-up or step-down procedure; in each case I performed both analyses and found the same results.

3.4.1 Did Participants Begin More Often with Goal or Source-Referents?

The first question I asked was "Who was referred to first?" Here I was interested in whether participants would begin their responses more often with references to goal- or source-referents. However, I expected that grammatical functions would interact with any effect of thematic roles. I therefore looked at the difference between goal- and source-referents separately for subject- and object-of-PP referents, calculating the proportion of references to goal- and source-referents for each category. The results are in Figure 2.

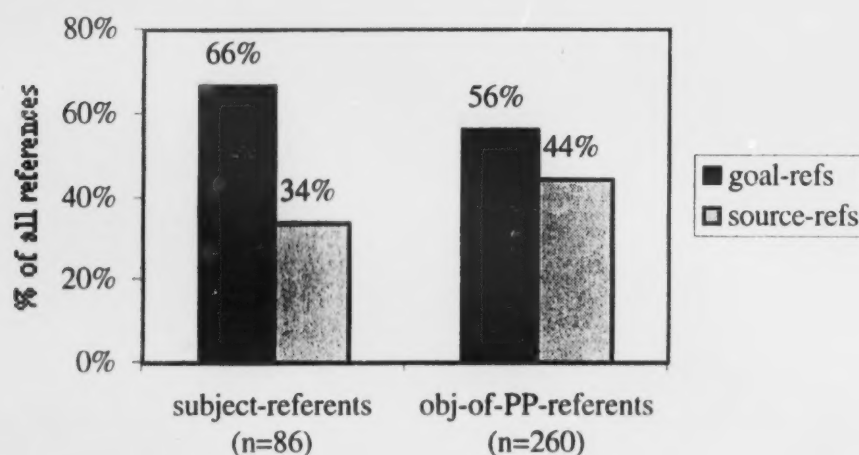


Figure 2. Distribution of choice of referent by grammatical function and thematic role.

The results revealed a goal bias for both subject referents and object-of-PP referents, in that the rate of reference to subject-referents was sensitive to verb type (goal-source vs. source-goal) ($-2 \times \text{Log LR} = 8.467$, $df=1$, $p<.005$).¹ For

¹These statistics represent an analysis that included four additional variables: 1) subject identity, 2) definiteness of theme NP, 3) presence vs. absence of end material, and 4) connection type. Subject identity was included to account for individual variation among subjects; this factor proved to account for a significant portion of the variation ($-2 \times \text{Log LR}=32.6$, $df=15$, $p<.006$). Definiteness of theme NP also reliably accounted for a significant portion of the variance ($-2 \times \text{Log LR}=9.1$, $p<.005$), in that subjects were more likely to begin with a reference to the goal referent when the theme NP was definite. The motivation for including the other two factors (end material and connection type) will be explained later.

both subject- and object-of-PP-referents, they were more likely to be the first referent of the continuation sentence if they were also the goal.²

The primary reason for considering *who* was referred to more often was to compare goal continuations with source continuations. In this regard, the experiment produced the expected results. However, a secondary, unexpected result was also observed: participants continued the discourses more often with the object-of-PP referent ($n=260$) than the subject NP ($n=86$). This result was surprising, because it goes against the finding that discourses are more likely to be continued with reference to subject-referents than other entities (Arnold 1999), and the more general tendency for subject-referents to be more accessible than object-referents (e.g., Gordon et al. 1993, McDonald and MacWhinney 1995, Stevenson et al. 1994).

One possible explanation of this result is that the story-completion method produces a task-specific recency effect. In normal production, recency effects are modulated by the subject bias, and speakers are more likely to refer to subject entities than object entities (Arnold 1999). This is likely to reflect the fact that subject entities tend to be more central to the discourse than object entities, perhaps because speakers tend to place more central entities in subject position. By contrast, this experiment did not reflect pure production processes, and participants were required to generate a continuation as they finished reading the stimulus. The object-of-PP character almost always appeared as the final element in the stimuli items, which may have caused it to be more activated at the point when participants were constructing their response.

The stimulus design offers a way to test this hypothesis, because in 5 of the stimuli, the object of PP did not appear as the last element in the utterance. These stimuli are shown in (4).

²For comparison I also performed an analysis that included *all* references to the goal or source arguments, and not just the first one. This procedure yielded more data points, because in many cases a single continuation contained references to both the source and the goal referents. These results followed the same pattern as the results using only the first references.

**% Proportion of references to goal and source referents,
calculated separately for subject- and object-referents**

	goal-referents	source-referents
Subject-referents ($n=126$)	68%	32%
Object-of-PP-referents ($n=286$)	56%	44%

(4) Stimulus-final sentences that contained material after the object NP.

- Marguerite caught a cold from Eduardo two days before Christmas.
- Juan received a telegram from Claire when their mother died.
- Phil paid \$200 to Emily for a full weekend.
- Melora taught a sonata to Mike in an hour and a half.
- Sam brought flowers to Ali in the hospital.

I compared the results for these items with the other items, to see if the tendency to continue with the object would disappear. There was a slightly higher tendency to refer to the subject referent in items with end material (35% of 37) than in items with no end material (24% of 309). However, the effect of end material (present vs. absent) did not reach significance when entered into the logistic regression. Therefore the corpus analysis, described below, provides an important test of whether the object-of-PP bias is a true effect, or a side-effect of the experimental methodology.

3.4.2 Were Pronouns Used More for Goal or Source-Referents?

I now turn to the second question, which concerns *how* goals and sources were referred to. I looked at four different categories of referent: subject/goal-referents, subject/source-referents, object-of-PP/goal-referents, and object-of-PP/source-referents. For each category, I counted the percentage of cases in which pronouns were used, out of the total number of references to a referent of that type. The results, presented in Figure 3, showed that pronouns were used more for goals than sources, but the effect is most prominent for object-of-PP entities.

The data in Figure 3 reveal two patterns. First, the use of pronouns was far greater for subject referents ($-2^* \text{Log LR}=125$, $df=1$, $p<.0001$). Second, pronouns were used more for goals than sources. However, this effect occurred primarily for object-of-PP referents, as indicated by the reliable interaction between grammatical function and thematic role ($-2^* \text{Log LR}=4.4$, $df=1$, $p<.05$).³

³As in the previous analysis, subject identity was entered into the logistic regression to account for individual variation among subjects. This factor contributed significantly to the model ($-2^* \text{Log LR}=62$, $df=15$, $p<.001$).

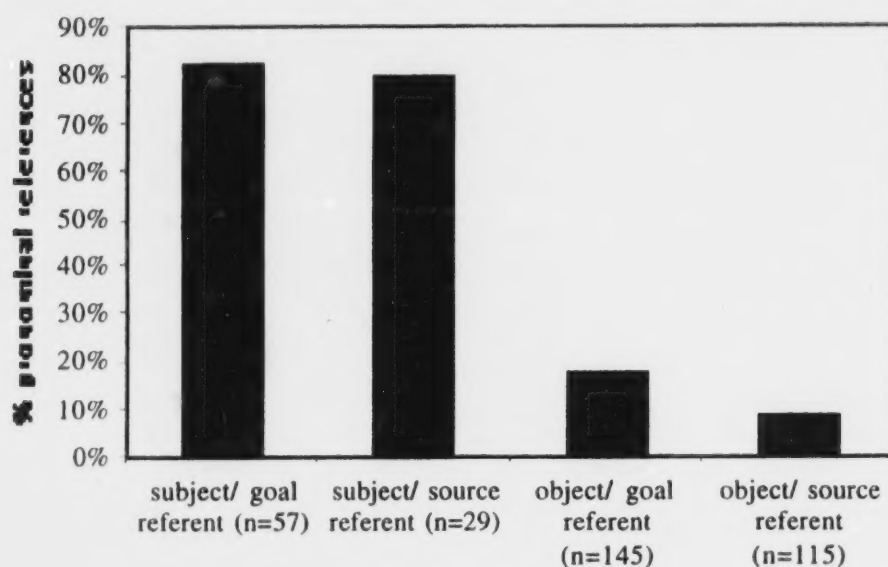


Figure 3. Percentage pronominal references by referent type.

3.4.3 The Relationship of Continuation Sentences to the Story

As I mentioned above, the stimuli contained no overt connectors to bias the relationship of the continuation sentence to the rest of the story. Instead, the types of continuations that people produced were the result of their reaction to other aspects of the stimuli. As participants read the stimulus story, they had to form a mental model of the characters and actions, and these mental models were influenced by the form and meaning of the three stimulus sentences.

Because this was an oral task, it was also at a rate that is close to normal speaking. Participants' responses therefore to some extent reflect the on-line processes occurring at the moment they add a continuation sentence. In particular, they reflect the cognitive status of the discourse referents, and the participants' assumptions about where the discourse is going. For example, participants may focus on a causal continuation for the story, a specification of a subsequent event, or some other type of continuation. Although the data do not reveal *why* they focus on one type of continuation rather than another, their responses do indicate *what* the type of continuation was.

Therefore, as I mentioned above, I coded each continuation sentence for continuation type. Figure 4 shows the distribution of responses across the four continuation types, considering the entire set of responses. These data

show that the most frequent type of response (43%) provided information about the consequences of the event.

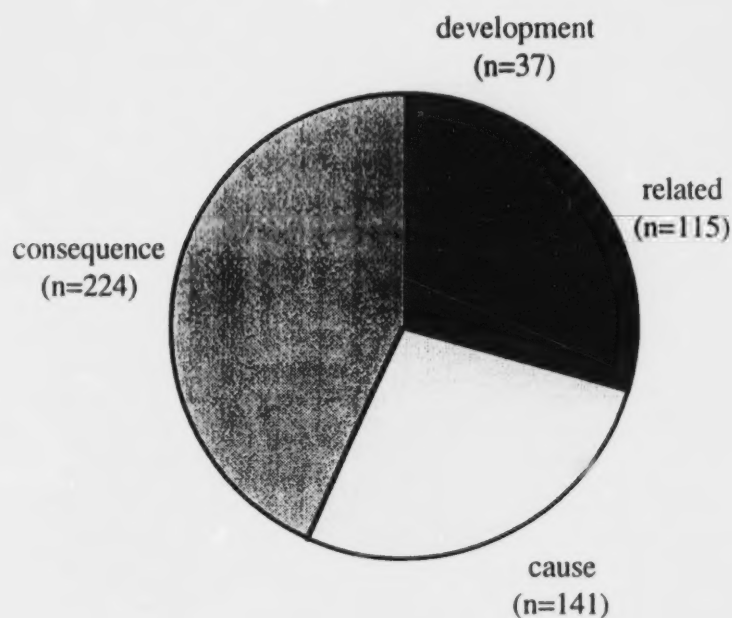


Figure 4. Percentage of all responses corresponding to each continuation type.

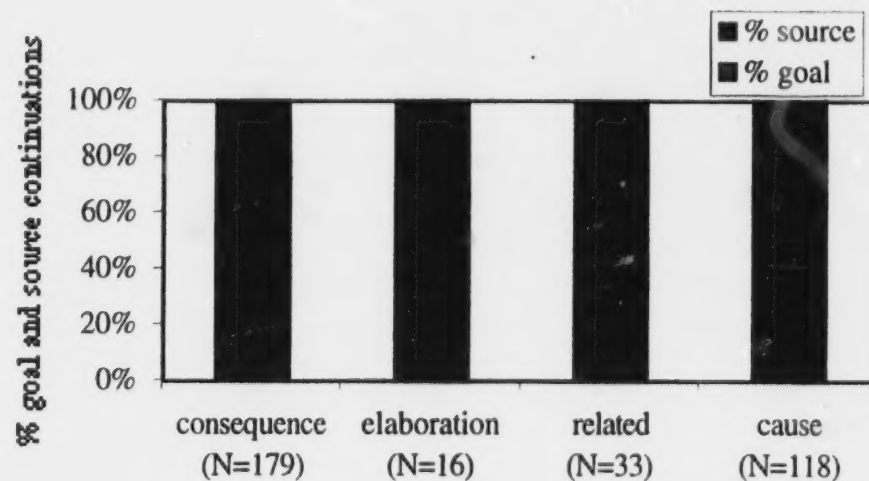


Figure 5. Proportion goal- and source- continuations in each category of thematic role and clause relationship.

Figure 5 shows the distribution of goal- and source continuations across each of the four continuation types, which indicate that goal continuations are most common in responses that focus on the consequences. This factor contributed significantly to the logistic regression model for *who* was referred to first ($-2 \times \text{Log LR} = 42.5$, $df=3$, $p < .005$).

3.5 Discussion

The results from the thematic roles experiment showed that participants tended to continue stories with goal-referents more often than source-referents, and also that they tended to use pronouns more often for goals than sources. The primacy of the goal-referent, in comparison with the source-referent, is consistent with the findings of Stevenson et al.'s (1994) written sentence completion task and Stevenson and Urbanowicz's (1995) reading time experiment. Furthermore, the results showed that participants tended to refer more often to goal referents than source referents. This suggests that the accessibility of goal referents is linked to a more general discourse pattern, whereby speakers more often focus their discourses on goals than sources.

At the same time, the results showed that the goal bias was stronger for some conditions than others. Specifically, when participants chose to explain something about the consequences of the event, they tended to talk about goal-referents more than source-referents. However, they did not always focus on the consequences, and when they didn't, the rate of reference to the goal-referent declined.

Thus, the goal bias for continuations about the consequences matched the goal bias in the full sample of continuations. The continuations about consequences were also more frequent than any other type of continuation. Therefore, the goal bias observed in the full sample may have occurred because of a bias toward focusing on the consequences of the stimulus event. In this sense, the results are consistent with Stevenson et al.'s claim that comprehenders tend to focus on the consequences of an event.

However, my results are not consistent with Stevenson et al.'s suggestion that focusing on the consequences is the default, which can be modified by connectors like *because*. In a task like this one, where there were no connectors, their account would predict that the large majority of responses should focus on the consequences. Contrary to this prediction, more than half of the responses did not. This suggests that these data are not best explained in terms of a default rule, an issue I will return to in section 5.

In sum, the data from the experiment showed two general patterns. People referred more to goal- than to source-referents, especially when they focused on the consequences of an event. They also used pronouns more often for goal- than source-referents. However, the results were also perplexing in one aspect: participants continued the stories with the non-subject referent

more often than the subject referent. This contradicts the known accessibility of subject-referents, and the finding that subject-referents are more likely to be referred to again than non-subject referents (Arnold 1999). This issue was further investigated in a corpus analysis, described below.

4 Corpus Analysis: Thematic Roles

The purpose of this corpus analysis was to investigate patterns of discourse with respect to goal- and source-referents. Do people refer more often to referents that have played certain thematic roles?

4.1 Methods

I conducted a corpus analysis, using the Aligned-Hansard Corpus from 1986. The Aligned-Hansard corpus is a collection of transcripts from the Canadian Parliament, so the discourse it represents is natural and communicative, albeit formal. I extracted samples of sentences containing the verbs listed in 5.

I only included instances where the verbs were used with both a source and a goal argument. As in the experiment, I limited the study to verbs used in the prepositional frame. I did this so that my sample of goal-source verbs would be comparable with my sample of source-goal verbs, which only occur in the prepositional frame.

(5) Verbs used in the corpus analysis

SOURCE-GOAL VERBS		GOAL-SOURCE VERBS	
<u>verb</u>	<u># examples</u>	<u>verb</u>	<u># examples</u>
give	22	get	19
send	19	accept	18
teach	1	receive	25
offer	20	buy	2
pay	20	take	20
		learn	5
TOTAL	82		89

For each sentence in my sample, S1, I identified the next 'independent' utterance, S2. I defined 'independent utterance' as a clause which is finite, not a sentential complement of the matrix clause, and not a relative clause. I then found the first expression in S2 that referred to something from S1, if there was one, and coded whether this expression referred to the goal-referent, source-referent, or other referent from S1. Examples are shown in (6).

(6) Examples from the thematic roles corpus analysis.

First reference	Example
Goal (subj)	S1: <u>We</u> will buy what we want offshore from the United States or elsewhere. S2: <u>We</u> do not have to care whether ...
Source (subj)	S1: Individuals write, phone and visit us and all ask if <u>we</u> can give any assistance to them, their relatives or friends who are seeking gainful employment. S2: <u>We</u> know their frustration ...
Goal (obj of PP)	S1: Mr. Speaker, I rise today to pay special homage to <u>a truly vibrant and magnificent lady</u> on her sixtieth birthday. S2: <u>She</u> has always had a reputation for congeniality and fairness toward all mankind.
Other	S1: I will hasten to send <u>this good message</u> to the Quebec Minister of Finance. S2: <u>It's</u> a comment which, I think, he will appreciate tremendously.

4.2 Results and Discussion

The results of this corpus analysis were tabulated separately for goal-source verbs and source-goal verbs. For each verb type, I counted the number of references to subject referents, object-of-PP referents, other referents from S1, and no referents from S1. Note that for goal-source verbs, the subject referent was also the goal-referent, and for source-goal verbs, the object-of-PP referent was also the goal-referent.

The results show that the goal-referent was mentioned more often than the source-referent ($\chi^2(1) = 6.091$, $p < .02$). Figure 6 shows the percentage of references to goal- and source-referents separately for subject- and object-of-PP-referents. The bars in Figure 6 do not add up to 100%, because the percentages are calculated out of all utterances in each sample, but Figure 6 does not include the cases when S2 did not contain a reference to either the goal- or source-referent.

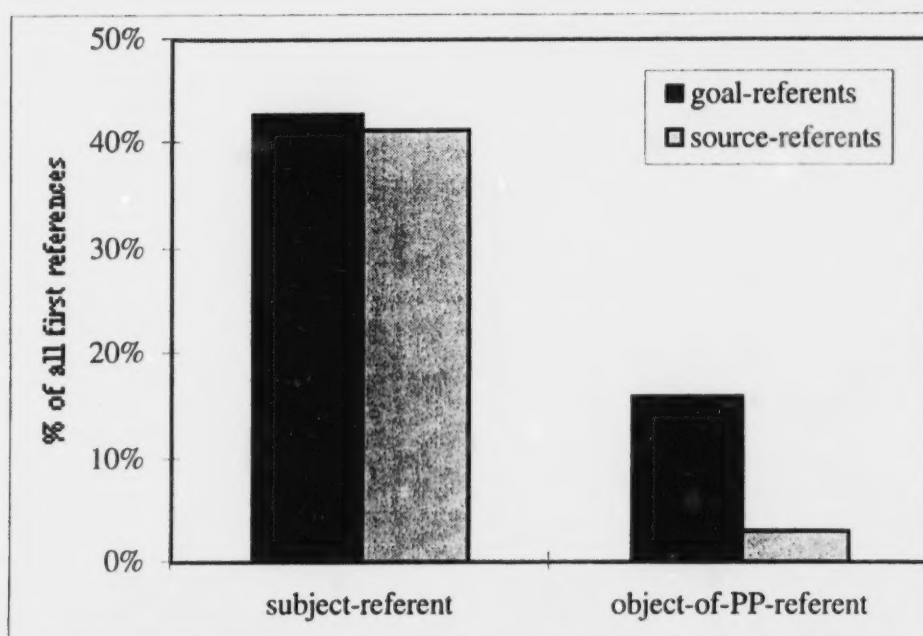


Figure 6. Corpus Analysis results: percentage of goal- and source-continuations, presented separately for subject- and object-of-PP-referents.

These data show three patterns. First, there was a large effect of grammatical function. That is, speakers referred to subject referents more often than other referents. This is consistent with my findings elsewhere that subject referents get referred to more often than others (Arnold 1998, 1999). It also suggests that the object-of-PP bias in the thematic roles experiment was the result of the experimental task, and was not indicative of a tendency to focus on objects of prepositions with this type of verb.

Second, there was an effect of thematic roles. This effect is largest for the object-of-PP category, where there were more references to the goal-referent than the source-referent. This supports my hypothesis that the accessibility of goal referents is linked to the tendency for speakers to refer more often to entities that have played the role of goal. More specifically, the referents that play the role of goal are somewhat more likely to be referred to in the following utterance.

Third, there was an interaction between grammatical functions and thematic roles. That is, for subject referents, it did not matter whether the referent was also a goal or not. But for object-of-PP referents, it mattered a great deal: goal-object-referents were referred to again far more than source-object-referents. To test the reliability of this interaction, I considered the items with subject-referents and object-of-PP referents as separate samples,

and asked whether the proportion of goal-referents was different in each of these two groups. I computed the z-statistic for comparing two proportions, and found that Goal Status indeed had more of an effect when the referent was also a prepositional object than when it was a subject ($z=-2.09$, $p<.05$). This interaction is consistent with the findings about pronoun use in the experiment, as well as with Stevenson and Urbanowicz's (1995) reading time data for names and pronouns, presented in Figure 1.

5 General Discussion

The results of the experiment and the corpus analysis show that two generalizations can be made about verbs of transfer. First, speakers tend to talk more often about the goal- than the source-referent. Second, speakers tend to use pronouns more often to refer to the goal- than the source-referent.

In the following section, I will use these parallel findings to argue for a new framework for understanding how thematic roles influence referent accessibility and pronoun use. In 5.1 I review some of the problems with past approaches to this issue. In 5.2 I present a multiple-constraints framework for understanding the effects of thematic roles.

5.1 Problems with Past Accounts

As described in section 1, past research on thematic roles and referent accessibility has focused on two factors: verb bias and overt connector words like *because*. Most work has proposed that the verb bias results in a focus on the implicit cause of the event (e.g., Garvey and Caramazza 1974, McDonald and MacWhinney 1995, Garnham et al. 1996). Stevenson et al. (1993) proposed instead that the verb bias varies across verb classes, such that the default bias is to focus on the consequences of an event, when the verb denotes an event. In all work, the proposed verb bias was found to vary depending on the connector word between the verb-containing clause and the pronoun-containing clause.

There are two main problems with these accounts. First, they tend to describe verb biases as categorical focusing strategies or default behaviors. This suggests that verb bias effects should be more homogeneous than they actually are. As shown in Figure 4, 57% of the responses in the story-completion experiment did not provide information about the consequences. This suggests that while these verbs do produce a tendency to focus on the consequences, this tendency is by no means a default behavior.

The second problem with these accounts concerns the role of connector words. While connector words do play a role, it is important to note that the reason they have the effect that they do is because they provide strongly constraining information about how the two clauses relate to each other.

As comprehenders interpret a discourse, they build representations of the entities, relationships between them, and events described by the discourse. In addition, they also need to build representations of how the propositions in two consecutive clauses relate to one another. While connector words can provide strongly constraining information about what these relationships are, they are not always present. Furthermore, even when they are present, they do not provide categorical information about clause relationships. For example, the conjunction *and* can have many interpretations (Schmerling 1975), some of which are in (7).

- (7) a. Temporal: I wrote my dissertation and filed it.
- b. Causal: It was cold and she put on her jacket.
- c. Simultaneous: I listened to music and looked out the window.

Other connectors, like *because*, more strongly indicate the speaker's intentions. However, even *because* is ambiguous to the extent that it can signal cause in one of three domains, as in (8).

- (8) a. Cause of real-world action: John came back because he loved her.
 - b. Cause of speaker's knowledge: John loved her, because he came back.
 - c. Cause of speech act: What are you doing tonight, because there's a good movie on.
- (from Sweetser 1990:77)

In sum, the relationship between thematic roles and referent accessibility can not be fully described in terms of default verb biases and overt connector words.

5.2 A Multiple-Constraints Framework

In this section I will outline a new framework for thinking about thematic roles and referent accessibility. Here I am taking a multiple-constraints approach which has been developed to explain speech and sentence processing (e.g., MacDonald et al. 1994, Marslen-Wilson 1990, Trueswell and Tanenhaus 1994), and applying it to the explanation of discourse phenomena. Under this approach, I am assuming that language use is a dynamic process, whereby discourse referents become more or less accessible as the result of various sources of information. I use the metaphor of partial activation to describe varying levels of accessibility, where the level of activation represents the level of referent accessibility.

My proposal is centered around understanding how thematic role information can be used by comprehenders to infer how important a given referent is to the discourse. How does the comprehender know which referents the

speaker considers more topical? Which referents are most likely to be referred to again? This inference is necessary for speakers and comprehenders to coordinate their individual models of referent accessibility in the discourse. When speakers know that comprehenders are likely to have a sufficiently activated representation of a given entity, they also know that reference resolution will be facilitated for the comprehender. When comprehension is facilitated, speakers are licensed to use underspecified forms of reference like pronouns.

Underlying this proposal is the idea that language processing involves unconscious hypotheses about where the discourse is going, and that they influence the activation of discourse referents. The listener's predictions about the discourse flow are neither conscious nor categorical. Rather, certain referents are activated probabilistically, for a short period of time, as various kinds of information become available. Activation is influenced by many sources of information, including the thematic roles of referents in the preceding clause.

5.2.1 Pronoun Use and Frequency of Reference Continuation

The experiment results showed that speakers use pronouns more to refer to goal referents than source referents. This finding, which is consistent with previous results about pronoun resolution (Stevenson and Urbanowicz 1995), suggests that goal referents are more accessible than source referents at the point when they are referred to. What explains this accessibility?

Given a dynamic framework for understanding language processing, the second finding from this paper offers an explanation. Both the experiment and the corpus analysis showed that speakers refer more frequently to goal referents than source referents. This indicates that from the comprehender's point of view, it is more probable that the speaker will refer to the goal referent than the source referent.

Based on this finding, I propose that the accessibility of a given referent, which can be modeled in terms of activation of its representation, is driven by the likelihood that it will be referred to again in the following discourse (either directly or through a bridging inference). When a referent is likely to be referred to again, it behooves comprehenders to instantiate a relatively activated representation of that referent in their model of the discourse. Then, if the speaker does refer to that entity again, comprehension will be facilitated.

How do comprehenders estimate the likelihood that a referent will be continued in the discourse? Here I have shown that thematic role information can be useful. In Arnold (1998, 1999) I also showed that factors like order of mention, parallelism, recency, and focus constructions also provide information about the likelihood for a given referent to be continued in a discourse.

Furthermore, the data in this paper show how thematic role information interacts with order of mention: the increased likelihood for goals to be mentioned again occurs primarily for object-of-PP referents, and the pronoun preference for goals also occurs primarily for object-of-PP referents. In addition, the experimental data suggest that the likelihood for goals to be continued is influenced by the type of continuation, supporting Stevenson et al.'s findings that goals are most accessible when comprehenders focus on the consequences. These facts suggest that (a) thematic role biases are relatively weak, and (b) they are contingent on other factors, like the perceived contribution of the next utterance.

There are several ways the comprehender might estimate the increased probability of reference to goal entities. It might be that through experience and observation of language use, people learn that other people tend to refer to goal referents more often than source referents.⁴ This information could then become accessible whenever a goal referent is encountered. Alternatively, it may be that comprehenders infer this probability through a more complex evaluation of the current discourse and the particular speaker's goals.

Either way, when the comprehender can estimate a relatively high probability that a particular referent will be mentioned, this probability can be translated into a higher activation for that entity, and therefore a higher level of accessibility. If the speaker does refer to that entity, comprehension should be facilitated. In this condition, the speaker can use less specified forms of reference, like pronouns. For referents that are relatively less likely to be mentioned, their representations will receive a lower level of activation, so speakers will need to use fuller forms, like names, to refer to those entities.

There are two ways that this probability may influence the subsequent interpretation of pronouns. Some researchers have presented thematic role effects in terms of focusing (the 'focusing account'): as comprehenders determine the role of a referent in a particular event, that information influences the cognitive status of the referent, making it more, or less, accessible (e.g., Stevenson et al. 1994). During the comprehension of the next clause, referent accessibility influences the interpretation of referring forms. Other researchers have claimed that thematic role effects only come into play later, during either anaphor resolution or the integration of the anaphor with the discourse (the 'resolution/integration account'), and do not influence the representation of discourse entities beforehand (Garnham et al. 1996, McDonald and MacWhinney 1995, Stewart et al. 1998). Under either account, the discourse

⁴Why it is that speakers refer to goals more often than sources? The studies described here show that people do talk more about goals than sources, but they do not explain why. Speculatively, it is likely that speakers talk about goals, in particular in narrative genres, because people tend to care about the outcomes of events.

patterns observed in the corpus analysis could play a role. Under the focusing account, the higher probability of goal referents to be mentioned again can be interpreted in terms of anticipatory activation on the representations of goal entities, before the pronoun is encountered. Under the resolution account, the activation of highly probable entities would not occur until after the anaphor has been encountered.

5.2.1 Clause Relationship as a Multiple-Constraints Process

As in prior work, my data suggest that the effect of verb bias is mediated by the way in which comprehenders perceive two clauses as relating to each other. By contrast with prior work, which has discussed only overt connector words, I suggest that this perception is built up dynamically during the comprehension process, and doesn't occur at any single point in time. Furthermore, it can be influenced by many constraints, of which connectors are only one.

I propose that, like referent representations, the representation of clause relationships can be thought of in terms of partial activation over representations of relationship types. At the beginning of a given clause, several relationship types might be partially activated. As the comprehender receives additional information over time, one relation will become fully activated, and the others will lose activation. Eventually only one relationship type will be selected.

What determines which relationship types are activated? As discussed above, connector words are strongly constraining, but even they do not provide completely categorical information. The influence of connector words can therefore be best understood as partial, probabilistic constraints. That is, a connector like *because* might signal a high probability that the following clause will contain causal information, and would therefore highly activate a causal interpretation. A connector like *and*, on the other hand, weakly activates several different relations. *And* provides less constraining information, leaving the listener to interpret the relationship on the basis of other factors.

Other constraints that may play a role include discourse genre, tense, or aspect. For example, (9a) may be more likely to be followed by another event than (9b).

- (9) a. John raked the lawn. (Then he went inside).
- b. John rakes the lawn. (But I never do).

Even though both (9a) and (9b) use the same verb, the use of the past tense in (9a) makes it more likely to be perceived as part of a narrative, in which case it is more likely that the speaker will follow up with a description of a subsequent event. In contrast, the simple present tense in (9b) turns it into a

proposition about John's habits, which may be less likely to be followed by a description of a subsequent event.

There are several advantages to thinking of clause relationships as partial, probabilistic, and dynamic representations that are built out of several sources of information. First, it explains why participants form representations of clause relationships when connectors are not present, as in my data. Second, it explains, without relying on default processing rules, why Stevenson et al. (1994) found thematic role biases even for sentences with no connector, and why the goal bias in my data was strongest when participants focused on the consequences of the stimulus event. With no connector present, participants were influenced by other aspects of each sentence, such as the tense, aspect, genre, or, as Stevenson et al. suggest, type of verb. Third, this approach offers a more general explanation for Stevenson et al.'s finding that different biases exist for different combinations of verb types and connectors.

6 Conclusion

The data in this paper revealed two facts about goals and sources. First, reference to goal referents is more likely to be achieved with a pronoun than reference to source entities. Second, speakers are more likely to refer to goal referents than source referents overall. I suggested that the second finding may explain why goal-referents are more accessible than source-referents. I proposed that referent accessibility is driven by the comprehenders' estimation that a given referent will be continued in the discourse, based on their knowledge about the frequency of continuation of goal and source referents.

At the same time, these data show that the effect of thematic roles is relatively weak, compared with stronger factors like order of mention. The accessibility of goal-referents over source-referents was only measurable after controlling for grammatical function. Both the experiment and the corpus analysis also revealed an interaction, such that the effect of thematic roles on pronoun use and reference continuation is greatest for object-of-PP referents. In other words, thematic roles have an effect on referent accessibility only when other factors (i.e., order of mention effects) are less constraining.

Although there are many details to be worked out, this approach makes predictions about how other thematic roles should impact reference processing. In cases where it can be shown that speakers more frequently refer to entities that have played certain thematic roles, I would predict that both speakers and comprehenders should find pronouns more natural than fuller forms of reference.

Appendix A: Stimuli from the Story-Continuation ExperimentGoal-Source Verbs

1. I hate getting sick. It always seems like everyone gets sick as soon as it's vacation. Marguerite caught a cold from Eduardo two days before Christmas.
2. My physics class gets out at 7 PM and it's already dark then. A lot of people have trouble getting home. Annette usually catches a ride from Scott.
3. The U2 concert was sold out a week before the show. Scalpers were selling tickets for ridiculous prices. Fortunately Rafael got a ticket from Gabrielle.
4. My high school friends really try to keep in touch with each other. It's a lot easier now that we have email. Today Gladys got three emails from Carlos.
5. Getting a telegram always scares me. It has to be either great news or awful news. Juan received a telegram from Claire when their mother died.
6. No-one was supposed to know about the lay-offs in our company. Of course, everyone did anyway. Jennifer heard the news from Pablo.
7. The high school prom was around the corner. The whole senior class had agreed to do a performance of the Macarena. Sonia quickly learned the steps from Allen.
8. The day before the exam, my whole study group was in a panic. It was 3 AM, and no-one could figure out problem #3. Elizabeth had to borrow the notes from Art.
9. Anyone who's anyone in Washington should be seen at the presidential inauguration. It's also really important who your date is. Courtney accepted an invitation from Bruce.
10. Our class presentation went okay, but not great. No-one in our group is a good speaker, but some are better than others. Craig should take some lessons from Pam.
11. Yesterday was probably the most exciting football game in the high school's history. A fight broke out, but not among the players—it was among the cheerleaders. It started when Blaire grabbed the megaphone from Ed.
12. My little brother and sister got into a big fight the other day. They both wanted the last piece of Halloween candy. The fight ended when Greg snatched the candy from Linda.

13. Summer weekends are the perfect time to get away. There are many ways to travel besides cars. Last summer, Mimi rented an old bicycle from Victor.
14. It's funny how people like to point out how kids resemble their parents. But in fact it's often really striking. In my family, for example, Nick inherited big feet from Christine.
15. The amateur art show was held yesterday at the local high school. Some of the items were even for sale. Dan purchased a painting from Barb.
16. It's amazing the things you can buy used at Stanford. You can get things really cheap, especially at the end of the year when everyone is leaving. Last year Ryan bought a stereo from Delia for \$50.

Source-Goal Verbs

1. It was the final game in our company's softball tournament. The game was tied and everyone was on the edge of their seats. Fred threw the ball to Ginny.
2. The whole office was busy getting ready for the big presentation. It seemed like they would never be done. Finally Christopher handed the report to Stacy.
3. Yesterday we had our annual church picnic. We had a great game of "Toss the Egg". The best part was when Brett tossed the egg to Cathy.
4. The drama club was worried that no-one would come to the opening performance of their play. Everyone agreed to try to get all their friends to come. Erin sent an invitation to Bill.
5. Information travels fast in my school, especially gossip. When Jan and Andy broke up, everyone knew when, why, and how within days. It started when Marie told the story to Rick.
6. Yesterday our dorm's intramural basketball team played in the last game of the season. It was a big deal, because this game determined who would go to the finals. With 30 seconds to go, Holly passed the ball to Jason.
7. The students in my English class had to decide what order to give our presentations in. It was hard, because no-one wanted to go last. Tina offered the first slot to Matt.
8. The Jacksons had no trouble getting their beach house taken care of while they were on sabbatical. Lots of people offered to look after the place for them. However, Eloise had already rented the house to Andy.
9. Everyone pitched in to get the neighborhood party off the ground. Lots of people brought burgers and chicken patties. Phyllis loaned a barbecue to Wiley.

10. The professors in the music department were all in a good mood. The first day of music lessons had gone unexpectedly well. Melora taught a sonata to Mike in an hour and a half.
11. I'll never forget the Christmas party this year. Even the shy people were dancing. Cynthia taught the lambada to Sean.
12. Everyone was shocked when the Cowan family got into a car wreck. Everyone wanted to do something to show their sympathy. Sam brought flowers to Ali in the hospital.
13. There was so much food for Thanksgiving, we didn't even eat half of it. Everyone got to take some food home. Lisa gave the leftover pie to Brendan.
14. The Donaldsons recently moved to India. They had to get rid of everything before they left. Anna sold the couch to Frank.
15. The art museum was packed when the fire broke out. Everyone can remember exactly what they were doing when the alarm sounded. Ray was showing a Van Gogh to Betty.
16. There are lots of opportunities for teenagers to make money in part-time jobs. It's possible to make quite a bit of money by babysitting. Phil paid \$200 to Emily for a full weekend.

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Bilingual Code-Switching and the Open/Closed Class Distinction*

Ellen F. Prince and Susan Pintzuk

1 Introduction

Although much attention has been paid to the sociolinguistics of bilingual code-switching, it is only recently that syntactic constraints on the phenomenon have been investigated. For example, given a French-English bilingual who code-switches intrasententially, i.e., who produces sentences containing lexical material from the two languages, could that speaker equally well produce, for example, all the sentences of (1)?

- (1) a. *We* avons vu un tigre ['We have seen a tiger'].
b. Nous *have* vu un tigre.
c. Nous avons *seen* un tigre.
d. Nous avons vu *a* tigre.
e. Nous avons vu un *tiger*.
f. Nous *have seen* un tigre.
g. Nous avons vu *a tiger*.
h. Nous *have seen a tiger*.

The question is potentially of considerable interest because the investigation may well shed light not simply on intrasentential code-switching but also on a number of other phenomena. In particular, a study of how bilinguals code-switch from one language to another within a sentence may shed light on how monolinguals organize their grammar and process sentences, as pointed

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Note from the editors: This paper was written in 1984 but not published until now. We include it here in order to make this widely cited work more easily available. It has not been updated and so lacks all reference to recent work on the topic.

out in Joshi 1983 and in Woolford 1983. In addition, it may inform us on how bilinguals acquire and organize the grammar of their second language, as well as how they process sentences in it.

In what follows, we shall briefly review five theories of bilingual intrasentential code-switching, Pfaff 1979, Sankoff and Poplack 1980, Woolford 1983, Joshi 1983, and Doron 1981, and we shall show that none, as formulated, appears to account for the data. We shall then outline an independent theory of second language acquisition and processing that, taken together with a theory of code-switching along the lines of the one presented in Joshi 1983, does account for the data. Evidence from psycholinguistic research will be presented to support the reasonableness of our approach.

2 Review of the Literature

2.1 Overview

Formal code-switching grammars have been developed within two basic frameworks: (i) the two grammatical systems are kept separate, and a switching mechanism is developed to alternate between them, and (ii) the grammatical systems of the two languages are combined into a third grammar, with modifications of and/or constraints upon the syntactic rules. Within the first framework, each constituent, including the sentence itself, is assigned to one of the two monolingual grammars; constituents are switched from one language to another.

Within the second framework, constituents are assigned to a particular language only if the syntactic structure is unique to one of the two languages. Sankoff and Poplack (1980:11) justify the existence of a third grammar by observing that code-switching is not generally accompanied by "pauses, hesitations, repetitions, corrections, or any other interruption or disruption in the rhythm of speech." However, Doron (1981:3) points out that the smooth transition between languages indicates only that code-switching is not an "erratic performance phenomenon." As additional evidence for a third grammar, Poplack (1980) states that the switching is symmetrical between the two languages; however, this follows from her definition of a switch and is not an empirical finding. And Joshi (1983) notes that a third grammar entails unnecessary complications for the parsing of monolingual sentences. The only compelling evidence for a third grammar would be the existence of a constituent consisting of lexical items from two languages, with a structure which cannot be generated by either of the two monolingual grammars; such

evidence is not claimed to exist in any of the five theories described below, nor does it exist in our own data.¹

2.2 Pfaff 1979

Pfaff does not develop a formal code-switching model, but she does specify certain constraints on switchability, shown in (2):

(2) Pfaff's constraints

- a. Miscellaneous Category Constraint: Tensed verbs, clitic pronoun objects, and prepositions cannot switch.
- b. Order Constraint: Nouns and adjectives within a noun phrase cannot switch unless the order of the noun phrase constituents is the same in both languages.

The question of code-switching tensed verbs requires further discussion and will be returned to below. Counterexamples to Pfaff's other constraints are shown in (3):

(3) Counterexamples to Pfaff's constraints:

- a. Clitic pronoun objects
 inta hang -ha up.
 you it
 'You hang it up.'
 (English/Arabic: Mohamed 1983)

¹Aravind Joshi has pointed out to us that a third grammar might be needed to account for the portmanteau constructions reported in Nishimura 1983, e.g. (i), and for the noncausative readings associated with the auxiliary constructions reported in Joshi 1983 for Marathi/English and in Pfaff 1979 for Spanish/English, e.g. (ii) and (iii), respectively:

- (i) Look at the things she buys for Sean *ne*. [*ne*='for'].
 (English/Japanese: Nishimura 1983)
- (ii) *mi tyala ghar ghyayla persuade kela.*
 I to-him house to-buy *persuade* did
 'I *persuaded* him to buy a house.'
 (Marathi/English: Joshi 1983)
- (iii) *Su hija hace teach alla en San José*
 his daughter makes *teach* there in San José
 'His daughter *teaches* there in San Jose.'
 (Spanish/English: Pfaff 1979)

- b. Prepositions
 Il devient *bhal* un perroquet.
 he becomes *like* a parrot
 'He becomes *like* a parrot.'
 (French/Arabic: Bentahila and Davies 1983:315)
- c. Order Constraint:
Šalesmen dinamiyim can make a lot of money.
 'Dynamic salesmen can make a lot of money.'
 (Hebrew/English: Doron 1981:18)

That is, in (3a), we find an Arabic object pronoun cliticized onto an English verb; in (3b), we find an Arabic preposition in an otherwise French sentence; and, in (3c), we find an NP consisting of a Hebrew N and an English Adj, where the order of N and Adj in an NP is different in Hebrew and English.

2.3 Sankoff and Poplack 1980

Sankoff and Poplack work within the framework of a third context-free phrase structure grammar built from the two monolingual grammars. They propose two constraints, presented in (4):

(4) Sankoff and Poplack's constraints:

- a. Free Morpheme Constraint: No switch may occur between a bound morpheme and a lexical form unless the latter has been phonologically integrated into the language of the former.
- b. Equivalence Constraint: The order of sentence constituents on either side of the switch point must be grammatical with respect to both languages.

The lexicon of the code-switching grammar consists of the union of the lexicons of the two monolingual grammars. The set of grammatical categories is the union of the two sets of grammatical categories (marked for language). The set of phrase structure rules is the union of the two sets of phrase structure rules, modified as follows: if the switch of one of two adjacent elements of the right-hand side of a phrase structure rule violates either the Free Morpheme Constraint or the Equivalence Constraint, those two elements are marked as belonging to one of the two monolingual grammars.

Counterexamples to Sankoff and Poplack's constraints are shown in (5):

(5) Counterexamples to Sankoff and Poplack's constraints

- a. Equivalence Constraint:
 kahi *chairs* -war
 some on
 'on some *chairs*'
 (Marathi/English: Joshi 1983:7)
- b. Free Morpheme Constraint:
 ʔaiz t-shof el-ragl y- swim?
 want.pres you-see the-man *PROG* swim
 'Do you want to see the man *swimming*?'
 (Arabic/English: Mohamed 1983)

That is, in (5a), we find an English N in an otherwise Marathi PP, where the order of constituents in English and Marathi PPs is different (cf. also (3c), (7), (11b)); in (5b), we find an Arabic bound morpheme attached to an English free morpheme (cf. also (3a)).

2.4 Woolford 1983

In Woolford's model, the lexicons and word formation components of the two monolingual grammars are kept separate. Phrase structure rules from both grammars are used; but if a phrase structure rule is unique to one of the two grammars, then the nodes created by application of that rule must be filled by lexical items from that language. In addition, Woolford states that there are constraints upon the structures which can be manipulated by the transformational rules of each monolingual grammar. Crudely put, the general prediction of Woolford's theory is shown in (6):

(6) Woolford's constraints

- a. Word Constraint: There can be no code-switching within a word.
- b. Constituent Constraint: There can be no code-switching within a constituent in which the deep structure word order is different in the two monolingual grammars.

Woolford's theory makes no mention of the apparent non-switchability of certain lexical categories claimed by the others. We have found no counterexamples to Woolford's Word Constraint; a counterexample to her Constituent Constraint is shown in (7):

(7) Counterexample to Woolford's Constituent Constraint:

hia *funny* awi.

it so.

'It is so *funny*.'

(Arabic/English: Mohamed 1983)

That is, in (7), we find an AdjP consisting of an English Adj with an Arabic Adv, where the order of Adj and Adv in an AdjP is different in Arabic and English (cf. also (3c), (5a), (11b)).

2.5 Joshi 1983

Joshi's model maintains two separate monolingual context-free phrase structure grammars, and a switching mechanism is proposed to control code-switching between their corresponding constituents. One language is designated 'matrix,' i.e., the language to which the root S belongs, the other 'embedded,' i.e., the language to which the switched constituent belongs. There are two major constraints on the switching mechanism, outlined in (8):

(8) Joshi's constraints

- a. Asymmetry Constraint: Constituents can switch from the matrix language to the embedded language, but not vice versa.
- b. Closed Class Constraint: Closed class items cannot be switched.²

The notion of 'matrix language' requires further discussion and will be returned to below. Counterexamples to Joshi's second constraint are shown in (9):

(9) Counterexamples to Joshi's Closed Class Constraint

- a. It goes without saying I think *que* ['that'] along with the picketing we are doing a boycott.
(English/Spanish: Pfaff 1979:314)
- b. Any kind of book that's interesting, about Mafia *o* ['or'] love story *o* ['or'] sex books or things like that.
(English/Spanish: Sankoff and Poplack 1981:35)

²In addition, both Joshi's model and Doron's employ a parsing strategy which is not directly relevant to this paper.

- c. Where are they, *los* ['the'] language things?
(English/Spanish: Poplack 1981:175)
- d. El dentiste agarraba off y se iba *fishing*.
'The dentist would take off and go *fishing*.'
(Spanish/English: Pfaff 1976:254)

That is, in each of the tokens in (9), we find a closed class item in one language in a sentence of another language: a Comp in (9a), a Conj in (9b), a Det in (9c), and a Prt in (9d); cf. also (3a,b), (5b).

2.6 Doron 1981

Doron accepts Joshi's basic framework described above, to which she adds two additional constraints, as shown in (10):

(10) Doron's constraints

- a. [= 8a,b]
- b. Agreement Constraint: Lexical categories which must be marked for agreement cannot be inserted into a position unspecified for agreement. For example, Spanish adjectives, which are marked for agreement, cannot occur in an English noun phrase.
- c. Case Marker Constraint: Case markers, including prepositions, from one language cannot be mixed with noun phrases from another language.

Counterexamples to Doron's additional constraints are shown in (11):

(11) Counterexamples to Doron's additional constraints:

- a. Agreement Constraint:
I'm not *terca* ['stubborn'].
(English/Spanish: Pfaff 1979:305)
- b. Case Marker Constraint:
Sorekara, *his wife -ni* yattara.
also to give+COND.
'Also, if (we) give (it) *to his wife*...'
(Japanese/English: Nishimura 1983)

That is, in (11a), we find a Spanish Adj, which must agree in gender and number and which here is feminine singular, in an otherwise English sentence; English Adjs are not, of course, marked for agreement. In (11b), we find a Japanese PP consisting of an English NP and a Japanese preposition (cf. also (3b)).

2.7 Summary

In summary, the constraints posited by these five theories involve surface word order, lexical, morphological, and grammatical categories, and symmetry. We shall now present results from a research project which was carried out at the University of Pennsylvania on intrasentential code-switching in the speech of Yiddish-English bilinguals and which seem to falsify at least some part of each of the five theories outlined above.

3 Yiddish-English Code-Switching Study

3.1 Corpus

The research we are reporting is the result of an analysis of intrasentential code-switching data from approximately seven hours of taped and transcribed interviews with eight Yiddish-English bilinguals in Philadelphia and New York City. The speakers were 70 to 85 years old. Their native language was Yiddish; they had emigrated as young adults from Central and Eastern Europe to the United States, where they acquired English. Of the five interviewers, one was fluent in Yiddish, two others knew some German and could therefore understand some Yiddish, and the remaining two neither spoke nor understood Yiddish or German. The interviews were conducted with no interest in or awareness of the phenomenon of code-switching and indeed were expected to be entirely in English. A total of 247 tokens of intrasentential code-switching were found and analyzed.

3.2 Criteria

A few words are in order here on the criteria used for, first, identifying an utterance as a token of code-switching and, second, coding an utterance once it has been so identified.

3.2.1 Criteria for Identifying Code-Switches

Deciding whether or not some utterance is or is not an instance of code-switching is highly problematic, which fact we feel has not been sufficiently appreciated in much of the literature. Languages in contact may interact in a variety of complex ways, of which code-switching is but one. Thus, the fact that a sentence appears to contain lexical material from more than one language does not entail that it is an instance of code-switching, and several (often fuzzy) distinctions must be made.

First, there is the well-known problem of distinguishing code-switching from borrowing. The distinction is important since a speaker who utters a sentence containing a borrowing is speaking a single language; thus monolinguals, for example, may well utter sentences containing a borrowing. In contrast, code-switching involves the simultaneous management of two languages. The usual test for distinguishing borrowing from code-switching is phonological: if some item has been borrowed from some foreign language, L2, into one's native language, L1, it will be phonologically adapted to L1; if it has been code-switched, it will not.³ This test was not useful in our study, since our speakers all have, as far as we can tell, one phonological system, not two. In other words, they have a strong Yiddish accent.

The criterion we did use was to eliminate as borrowings those items which seem to be used by some monolingual English speakers, at least those in the large urban areas of the northeastern United States.⁴ We are not entirely happy with this criterion, since the real distinction is whether the utterer takes the item in question to be a borrowing or not, i.e., has the (originally L2) item in his/her L1 lexicon, not whether some other group of speakers does.

Second, there is the equally well-known problem of distinguishing code-switching from interference, the influence or intrusion of one language on another as a result of an 'incomplete model' of the latter. Since we could find no test other than whether the apparent switch was intended or not (cf. Albert and Obler 1978:12), a test that we, for obvious reasons, could not apply, we presumed no interference and included all apparent code-switches

³Note that this test is what underlies the condition on Sankoff and Poplack's Free Morpheme Constraint, presented in (4a) above. That is, Sankoff and Poplack are disallowing the cooccurrence of a bound morpheme and a free morpheme where one of them has been code-switched; they are allowing it, of course, where the free morpheme has been borrowed.

⁴Cf. Webster's *Third International Dictionary*, *schlepp* [slang] 'drag', 'haul', also 'steal'.

other than borrowings in our corpus of code-switches. We shall return below to the notion of interference.

Finally, it should be noted here that the English of the eight bilinguals is not 'standard.'⁵ However, there is no doubt that they do speak some dialect of English; in fact they all speak more or less the same dialect, and the non-standardness of that dialect is, we feel, irrelevant. This, of course, is related to the problem of interference.

3.2.2 Criteria for Coding Code-Switches

Once an utterance has been identified as an instance of code-switching, the problem arises of coding it in a principled and non-ad hoc way. There were basically three important decisions that had to be made in this domain in this study.

First, for each mixed sentence, the matrix language had to be determined. Following Joshi 1983 and others, we used the tensed verb of each tensed S to determine the matrix language of that S, from which it follows, by the way, that by definition we cannot have a tensed verb code-switched, one of the situations explicitly disallowed in Pfaff 1979. (See, however, Doron 1981 for data that cast doubt on this criterion.)

Second, for each instance of code-switching, it had to be determined which constituent or constituents were switched. We adopted the convention of taking the highest constituent of non-matrix items to be the switched constituent. Thus, for example, in (12a), we considered there to be a single switch (PP), rather than two switches (Prep, NP) or three (Prep, Det, N). In (12b), on the other hand, since the two switched items do not constitute a constituent, we considered there to be two switches (Prep, Poss. Pro.):

⁵For example, we find instances of nonstandard word order, e.g., (i), of subject and object pronoun drop, e.g., (ii) and (iii), respectively, and of a Slavic-type Gapping, e.g., (iv):

- (i) But today *is there* a lot of people out: who would help me. (SG.19ii)
- (ii) [Speaking of birthplace] [*e*] used to be Lithuania, but now [*e*] is Russian. (MK.5)
- (iii) [Speaking of the gem diamonds that he cut for a living] You pay if you eh if you break [*e*] or if you lose [*e*], yeh. (IF.166i)
- (iv) [R: You belong to the shul?] Ocean City. Two shuls. One Ø an old-fashioned, one is a modern... (YS.65)

- (12) a. Efsher zenen zey geven [[in] [[the] [gas chamber]]]... (SG.8i)
 maybe are they been
 'Maybe they were in the gas chamber.'
- b. Two years ago I had an operation [[oyf] [[mayn] [eye]]]. (MK.48)
 on my

Third, for each switch we had to determine whether an open class item or a closed class one was involved. To this end, we used the traditional division of open and closed class items, with one exception: coordinate sentence conjunctions were ignored, for the reason that we could not determine the matrix language of the higher S, following an analysis where the conjunction is immediately dominated by S, since that higher S has no tensed V by which we determine matrix language. Otherwise, all phrasal categories—Ss, NPs, (untensed) VPs, PPs, AdjPs, and AdvPs—as well as Ns, (untensed) Vs, and most Advs (e.g., *slowly*) counted as open; Preps, Conjs, Prts, Dets, Quantifiers, Complementizers, Pronouns, and some Advs (e.g., *too*, *not*) counted as closed.⁶

3.3 Analysis

At first glance, our data seem to present counterexamples to all of the theories described above and, in fact, suggest that there are no constraints at all on what can be switched. In particular, closed class items, disallowed in part or in whole by four of the five theories outlined above, appear eminently switchable, constituting 39 of the total number of switches, as seen in (13):

(13) Open/Closed Class Yiddish/English code-switching:

OPEN	CLOSED
151 [61%]	96 [39%]

Examples of both types are shown in (14-16):

⁶But cf. Weinreich 1953, Kean 1979 for arguments that certain closed class items are 'more closed' than others. Adverbs and prepositions are shown to be particularly problematic.

(14) Open class switches; English→Yiddish:

- a. N:
...a *melamed* ['teacher'] that eh lived in one room with his wife and eh... and the chickens and everything. (IF.103i)
- b. NP:
That's when they come, /a/ *khasene oder a levaye* ['a wedding or a funeral']. (SG.10ii)⁷
- c. AdjP:
But the climate in Philadelphia is *zeyer shlekht* ['very bad']. (SG.5i)

(15) Open class switches; Yiddish→English:

- a. N, NP, NP, PP:
Bay yene [years] iz nit geven [the eh casinos] oder
in those years is not been the casinos or
[something] [in Atlantic City].
something in Atlantic City
'In those years, there weren't the casinos or something in Atlantic City.' (MK.84)
- b. NP, NP, PP, NP, NP, PP, NP, NP, PP:
Ikh krig fun zey [widow pension], ikh krig [a widow pension] [from Aus-] fun [Germany], ikh krig [a widow pension] [from here], un ikh krig a [pension], [social security], [from Austria].
'I get from them widow pension, I get a widow pension from Aus- from Germany, I get a widow pension from here, and I get a pension, Social Security, from Austria.' (SG.18i)

⁷Unfortunately, there is a risk of ambiguity in our presentation of the data. English utterances are presented in standard orthography; hence the indefinite article is *a*, pronounced as schwa. Yiddish utterances are presented in standard YIVO transliteration, closely related to phonemic transcription; hence the indefinite article is *a*, pronounced /a/. Thus, in (14a), the article is English, whence a switched N, while, in (14b), both articles are Yiddish, whence a switched NP.

- c. PP, (untensed) S:
 [From Italy], hobn zey undz geholfn der folk: [to go out to
 from Italy have theyus helped the people to go out to
 Shanghai]...
 Shanghai
 'From Italy, the people helped us to go out to Shanghai.' (SG.8i)
- d. (Untensed) VP:
 'Khob [got out with: 32 children from Austria].
 I have got out with 32 children from Austria
 'I got out with 32 children from Austria.'
 (SG.8i)
- (16) Closed class switches:
- a. Comp: ...there wasn't an item *vos* ['that'] we didn't have. (IF.32i)
 - b. Prt: ...and it's hanging *arum* ['around']. (SD.17)
 - c. Prep: Bingo, Atlantic City, we go *mit* ['with'] the bus from the shul
 ['synagogue'; counted as borrowing; cf. Webster III]. (YG.65)
 - d. Det: ... *der* ['the'] operation came out wonderful. (MK.53)
 - e. Poss. Pro: It was *mayn* ['my'] daughter's house... (MK.30)
 - f. Pro: Shpeyter kimt men: till twelve years what *me* called in Vienna
 folkschool. ['Later comes till twelve years what *they/one* called in
 Vienna folkschool']. (SG.10i)⁸
 - g. Conj: ...look, a Jew was: a doctor, a lawyer, *oder* ['or'] a busi-
 nessman. (SG.47ii)
 - h. Adv: *Azoy* ['So'] is this. (IF.297ii)
 - i. Adv: *Efsher* ['Maybe'] they'll make it recorded. (YG.33)

However, it turns out that, when the tokens are coded for matrix language, an interesting pattern emerges: closed class switches are overwhelmingly confined to switches from English to Yiddish, which, in the population under discussion, amount to switches from L2, the nondominant language, to L1, the dominant language. The figures are shown in (17):

⁸See previous note; *me* here is Yiddish, a preverbal variant of *men*, 'one'.

(17) Open/Closed Switching by Matrix and Dominant L:

	OPEN	CLOSED
L1→L2	74	15
L2→L1	74	81
χ -square = 31.409		

At this point, the obvious question to be raised is why the situation should be as we have found it. That is, why is the open/closed class distinction salient in code-switching from L1 to L2, and why does this salience seem to disappear when the code-switching is from L2 to L1?⁹ Before suggesting an answer for this, we note that there is a relevant body of psycholinguistic re-

⁹One may wonder, of course, to what extent our Yiddish/English data are generalizable, that is, to what extent the same sort of asymmetry would show up in other corpora. Clearly, further research is required to shed light on this issue, but we note here that, in those theories cited which specify the informants' dominant language (Joshi 1981, 1983; Doron 1981), the data are consistent with the patterns we are finding: virtually no closed class switching when switching from L1 to L2. Further, consider the following observations by Bentahila and Davies (1983:326f.), reporting on Arabic/French code-switching by bilinguals dominant in Arabic:

...we find in our corpus many more examples where an Arabic determiner accompanies a French noun than we do of the contrary; prepositional phrases composed of an Arabic preposition and a French NP are much more common than ones where the preposition is in French and the NP in Arabic; and there are far more examples where an Arabic conjunction serves to link two French clauses than there are cases of a French conjunction linking two Arabic ones. In other cases, switches are common in one direction while there are no recorded examples at all of the same type of switch in the opposite direction. For instance, there are examples of Arabic demonstratives and possessives co-occurring with French nouns, of clauses in which the verb is in Arabic and the subject in French, and of the very common pattern where an Arabic disjunctive pronoun occurs in what is an otherwise entirely French sentence; but there are no instances of any of the reverse patterns... There is a tendency for [the Arabic-dominant] speakers to resort more to Arabic than to French for grammatical items or function words, such as determiners, pronouns, prepositions and conjunctions. Even when they are speaking mainly in French, they often use Arabic for such items... On the other hand, when speaking mainly Arabic, they seem to resort to French for lexical items, particularly for nouns, far more frequently than they have to resort to Arabic lexical items when speaking mainly French.

search that shows that monolinguals process open and closed class items differently, and it is to that evidence that we now turn.

4 Psycholinguistic Evidence for the Open/Closed Class Distinction

First, as is well known, children do not produce closed class items until the later stages of language acquisition, their absence being categorical in the holophrastic and two-word stages and typical in the telegraphic stage.

Second, and similarly well known, the literature on aphasia reveals that certain aphasias, e.g., anomia and Wernicke's aphasia, affect only open class items, traditionally called 'content' words, leaving closed class items, or 'function' words, intact, while the agrammatic aphasias, e.g., Broca's aphasia, have the reverse effect, i.e., impair the use of closed class items but not of open class items.

Third, Bradley (1978) reports that, while open class items show a strong effect of frequency ordering for lexical decision tasks, closed class items show no effect of frequency ordering for such tasks. That is, when subjects are asked to decide whether some item is a word or not, the amount of time required for the decision varies inversely with the frequency of the item if it is an open class word but does not vary with the frequency of the item if it is a closed class word. This suggests that open and closed class items are stored and/or accessed differently, e.g., that the two classes are stored in two sublexicons, with the items in the closed sublexicon of equal accessibility while those in the open sublexicon are accessed with respect to frequency. Further, Bradley, Garrett, and Zurif (1979) report that this difference becomes neutralized in the case of agrammatic aphasics, where closed as well open class items show an effect of frequency ordering. This can be accounted for, they suggest, if agrammatic aphasics add closed class items to their open class lexicon and lose their closed class lexicon.

Fourth, in studies of speech errors involving phonological metatheses within a sentence, e.g., spoonerisms, Fromkin (1973), Garrett (1980), and others show that it is the phonological material of open class items that is metathesized, usually over a fixed frame of closed class items. That is, the speech error in (18b) is possible; the one in (18c) is not:

- (18)a. a bone for Fido
- b. a fone for Bido
- c. *a fone bor Fido

Garrett (1980) suggests that the two classes of lexical items figure in two different levels of sentence-planning: a first level where the sentence is planned syntactically and where closed class items are selected, and a second level where open class items are selected. It is at the second level, Garrett suggests, that speech errors are made.

5 Proposed Explanation of the Code-Switching Data: The Translation Model

Thus, we see that, although little is known of the nature of the actual mechanisms involved, it is clear that non-aphasic monolinguals process open and closed class items differently. It is therefore not surprising that, in some cases at least, bilinguals treat the two classes differently when switching from one language to another intrasententially. The crucial questions, of course, are how (adult) language learners like our informants who show apparent closed class switching, acquire, store, and access closed class items in L2 and how it is that they apparently switch them to closed class items in L1. In the absence of definitive answers to these questions, we shall make a wild speculation on what the situation may be.¹⁰

First, we shall adopt, for all speakers, a two-level sentence planning mechanism of the sort Garrett suggests. That is, at the first level, the syntax is planned and closed class items are inserted, and, at the second level, open class items are inserted. Second, let us assume that, like speech errors, code-switching is not possible at the first level but is possible at the second level and that it works as described in Joshi 1983.

Let us now consider the case of speakers code-switching from L1 to L2, where virtually no closed class switching occurs. We see that their switching of open class items but not of closed class items follows from this view.

But what then of the case of speakers switching from L2 to L1, where apparent closed class switching is typical? We shall speculate that there is a difference in the acquisition of closed class items between L1 learners and at least some adult L2 learners. That is, perhaps some adult L2 learners do not construct a closed class lexicon for L2 as children must for L1 but rather learn the closed class items of L2 as *translations* of the corresponding items of L1. (Cf. the notion of "subordinate bilingualism," Weinreich 1953:10, *inter alia*.) When planning a sentence of L2 at the syntactic level then, they must access its closed class items *via those of L1*. Sometimes the access is completely successful, in which case the item appears in L2, but sometimes

¹⁰We take no stand, of course, on the manner of acquisition of those bilinguals who do not show apparent closed class switching.

it is only partially successful, i.e., the L1 item is accessed but not its L2 translation. In this case, the apparent effect would be one of code-switching: an L1 item appears in an L2 sentence, but in fact it is a case of premature selection rather than of code-switching and perhaps would be better characterized as a special case of interference.

We leave open the question of code-switching for these speakers at the second level of sentence planning, i.e., where open class items are stored. The Translation Model sketched here allows for three logical possibilities: (i) L2 items are directly accessed and may therefore be code-switched, (ii) L2 items are indirectly accessed as translations of L1 items (as in the case of the closed class items) and, if the corresponding L1 items are prematurely selected, there is putative code-switching, or (iii) a combination of (i) and (ii), i.e., some L2 items are accessed directly and code-switched and others are accessed indirectly, the corresponding L1 items being prematurely selected and giving the appearance of code-switching.¹¹

It is interesting to note that the Translation Model sketched here is entirely consistent with the theory of code-switching proposed in Joshi 1983 with respect to the asymmetry of the two languages involved and with respect to the non-switchability of closed-class items—this in spite of the fact that the data at first blush seemed to contradict Joshi's Closed Class Constraint.

6 Empirical Predictions of the Translation Model

In order to see more clearly what follows from such a Translation Model, let us consider briefly an alternative acquisition hypothesis that would equally well account for the data: suppose that adult language learners acquire all L2 items, both open and closed, as open class items. Call this the Only-Open Model. Presumably, such a model would have equal descriptive adequacy with respect to the switchability of L2 closed class items, since these would be processed at the second level of sentence planning, along with open class items, and it is at this level that code-switching is possible. However, it turns out that the Translation Model and the Only-Open Model make very different predictions on a number of other issues.

¹¹It is perhaps significant that, while none of the five theories we have discussed explicitly mentions dominance, Joshi (1983) leads us to infer that the matrix language is necessarily the speaker's dominant language. Further, Doron (1981: 31) seems to find this plausible. Whether in fact this is the case, even if only for some groups of bilinguals, requires further research. The Translation Model is neutral on this issue.

First, note that, following the Only-Open Model, the apparent switches of closed class items from L2 to L1 are in fact switches, while, for the Translation Model, they are not. Thus, the Only-Open Model predicts that they would exhibit the same contextual and sociolinguistic features associated with open class switches. In contrast, the Translation Model makes no such prediction. Here a study of contextual and sociolinguistic features of code-switching is in order. However, we point out that, in our data, open class switches differ from apparent closed class switches in that the former, but not the latter, are sometimes translated/glossed by the speaker. That is, for the four of our eight informants who ever translate anything for the interviewer, all such translations are of open class items. The figures are presented in (19):

(19) Open/Closed by Translated/Not Translated:

	OPEN	CLOSED
TRANSLATED	4	0
NOT TRANSLATED	31	25
χ -square = 15.558		

Here we count as Translated all English→Yiddish switches which are being or have been explicitly translated by the informant or for which a translation is or has been offered, for those informants who ever translate anything. We count as Not Translated all those informants' English→Yiddish switches for which no translation is being or has been given or offered and which item the interviewer has not used. (Reasonably enough, there is no case of an informant translating a Yiddish item that the interviewer has already uttered.) Examples of translations and offers thereof are given in (20):

- (20) a. So: but I went to the— to the Hebrew— to the *melamed*, to a Hebrew teacher. Now don't compare him with a Hebrew teacher here...
(IF.103i)
- b. My father was writing me that uh uh Shua will be a— will be a uh a rabbi, an *ilu*, you know a genius... (IF.223ii)
- c. And who were the owners, the owners you know what they were in Bardeyov, the boys?... *Tregers*. You know what a *tregers* is? [IF: They were drivers. AK: Peasants?] Dri— *tregers*, that brings eh

brings from the station: cartons, big cartons to the stores. [AK: Oh. Like porters, yeah.] *Tregers*, that's what they called them, *tregers*, yeah porters. (MF.201i)

- d. Ober ['but'] we eh don't have it: in the *kop* ['head']. You know what's a kop? [RP: Sure.] (YS.8)

Note, by the way, the instance of apparent closed class switching in (20d) (*ober* 'but'), which is, not surprisingly given our analysis, *not* translated (and not really 'switched').

Second, if experiments are carried out for adult bilinguals along the lines of those described by Garrett (1980) and Bradley (1978) involving lexical decision tasks of open and closed class items, the two models predict different results. The Translation Model predicts that response times for closed class items in L2 will be like those for closed class items in L1, except perhaps slower, i.e., with no frequency effect. In contrast, the Only-Open Model predicts that the response times for closed class items in L2 will be like those for open class items, i.e., will correlate with frequency, as is the case of the agrammatic aphasics reported in Bradley, Garrett, and Zurif 1979. While this experiment must of course be done to settle the issue, it should be noted at the outset that the bilinguals under discussion are not agrammatic aphasics and do in fact plan their sentences syntactically.

Third, the Translation Model predicts that a bilingual who demonstrates apparent closed-class switching of L1 items in L2 should not, following some brain lesion, exhibit agrammatic aphasia in L1 but not in L2. That is, if his/her L1 closed class lexicon is inaccessible, so should be the L2 translations associated with it. The Only-Open Model makes no such prediction; agrammatic aphasia in L1 should have no bearing on L2. We note here that none of the 108 case studies of polyglot aphasia reported in Albert and Obler 1978 where the subject acquired L2 as an adult involves agrammatic aphasia in L1 but not in L2, while two case studies seem to indicate the reverse situation.¹²

Finally, analyses of speech errors of bilinguals should reveal different patterns between L1 and L2. Following the Translation Model, there should be no metatheses of closed class items (or parts thereof) in L2, just as there are none in L1, since closed class items are selected at the first level of sentence planning. In contrast, the Only-Open Model predicts that L2 closed

¹²One case study, #76, involves motor aphasia in both L1 and L2; L2 returned "more syntactically impaired than" L1. The other, #83, involves agrammatism in written L2; "grammatical categories of [L1] interfered." (Albert and Obler 1978:130ff.)

class items, being psychologically indistinguishable from open class items and hence selected at the second level of sentence planning, should metathesize. That is, speech errors like (18c) should be just as likely as ones like (18b) in the speech of adult bilinguals speaking L2. Again, a thorough investigation of the facts should be done, but we note in passing that we find no errors like (18c) in our data and know of none reported in the literature.

7 Conclusion

In this paper, we have considered bilingual intrasentential code-switching and we have found that the ban on closed class switching claimed in much of the literature is at first blush contradicted by the data. Closer examination, however, reveals that the apparent closed class switching we find is virtually limited to switches from L2 to L1. In light of this, we tentatively propose a Translation Model of acquisition and production that appears plausible on independent psycholinguistic grounds and according to which the apparent closed class switching is in fact not switching at all but rather a sort of performance error of the type that has generally gone under the rubric of 'interference'. This Translation Model, taken in tandem with a theory of code-switching along the lines of Joshi 1983, appears to account for the data. Finally, we have enumerated several areas where the model can be tested empirically, research which remains to be done.

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Dialect Acquisition and Prestige

Clarissa Surek-Clark

1 Introduction

Recent sociolinguistic studies have provided some elucidation on the factors that influence dialect acquisition and language transfer. Chambers (1992) proposes eight principles of dialect acquisition based on research carried out with Canadian youths who had moved to Southern England. Two of his most important findings concern the child's age when the relocation takes place and the difficulty of the linguistic rule being acquired. The role parents play in language transfer is the object of Payne's (1976) study of Philadelphia dialect acquisition by children in King of Prussia, Pennsylvania. Her study finds it rare for a child native to and raised in King of Prussia whose parents are not Philadelphia natives to fully acquire the Philadelphia short *a* pattern. Kerswill's (1996) study of fronting of the offset of the diphthong /əʊ/ in southern British English shows that children as young as four years of age can develop a pattern which copies the pronunciation used by either parent or reach a compromise that falls in-between the pronunciation of their parents.

Elsewhere (Surek-Clark 1998) I have reiterated the importance of age of relocation and parents' dialect to mastery of a new dialect during one's teenage years. Designed with this foundational literature in mind, the present study aims to shed further light on dialect acquisition, adding a new influencing factor to the puzzle: relative language prestige. How can prestige influence the acquisition of phonological features in a dialect? Based on data collected from speakers of Brazilian Portuguese, I show that the prestige with which dialects are regarded in a particular community may influence the acquisition of a new dialect and that the relative prestige of one's parents' dialect plays a relevant role in the acquisition of a native dialect.

2 Brazilian Portuguese

2.1 Raising

The vowel inventory of Brazilian Portuguese (henceforth BP) is comprised of the following seven oral vowels: [i e ε a ɔ o u] and the nasal vowels: [ĩ ã

õ ù]. Back and front mid-vowels /e/ and /o/ undergo neutralization¹ in final non-stressed position in many BP dialects that are considered standard and as a result, three vowels surface in that position: [i, u, a]. For example: /leite/ → /leiti/ 'milk;' /carro/ → /carru/ 'car.' In the dialect of BP that is the focus of this study, these vowels do not necessarily undergo raising, even though the final /e/ is not realized as an absolute mid-vowel.

2.2 Palatalization

In most dialects of modern BP, a final raised /e/ triggers another phonological process: palatalization of /t/ and /d/ when followed by /i/. Palatalization occurs anywhere in the word in both stressed and unstressed syllables in the presence of an underlying /i/: *tia* [tʃia] 'aunt;' *dia* [dʒia] 'day;' *artigo* [artʃigu] 'article;' *pedir* [pedʒir] 'to ask;' *distrain* [dʒistrain] 'to distract.'

Raising feeds palatalization in cases in which syllables or words end in /e/ but are raised to /i/ (Bisol 1991):

	/‘pente/ ‘comb’	/me’dida/ ‘measurement’
Raising	i	-
Palatalization	tʃ	dʒ
	[pentʃi]	[me’dʒida]

The target BP dialect in this study does not strictly follow the current standard BP phonological rule of final /e/ raising and subsequent palatalization of /d/ and /t/.² This was historically attested to by the folklorist Roderjan (1969) in an observation to the effect that an attention-worthy feature of the speech of people from this area is their “open final /e/ and /o/ in phonetic pronunciation” (El-Khatib 1969: 153).³

To illustrate, a common example of this feature occurs in the folk saying *leite quente dá dor de dente* ‘hot milk causes toothache’ pronounced [leite

¹The literature also refers to this phenomenon as “raising,” and both terms are used with the same meaning here.

²The joint analysis of palatalization and raising as one phenomena in this study is due to the fact that there were no occurrences of non-palatalized /ti/ and /di/ syllables in the sample. It seems that in fact palatalization is automatically triggered by an /e/ which is sufficiently high to be perceived as an underlying /i/ or is an underlying /i/ itself.

³My translation from Portuguese.

kente da dor de dēnte] in the target city. In contrast, mainstream dialects pronounce it [leit̃ʃi kent̃ʃi da dor d̃ʒi dēnd̃ʒi] (Carvalho 1998).

3 The Study

Two groups of speakers were interviewed: a target vernacular group comprised of female adolescent speakers from the southern Brazilian city of Curitiba who belong to three distinct social classes. Data from this group enabled the construction of a baseline analysis of phonological features characteristic of the dialect spoken in this target area. Another group from which data was collected included migrant vernacular speakers, formed by female adolescent speakers who moved to Curitiba from three other regions: Rio de Janeiro; what I will call 'Other' raising areas (namely, areas where a dialect with greater prestige than the one spoken in Curitiba but with less prestige than the Rio de Janeiro dialect is spoken); and the 'Interior' group (speakers originally from the West of Paraná State). With the exception of the Curitiba dialect, all other dialects behave similarly in regard to raising and palatalization: they raise final /e/ and palatalize /i/ before /t/ and /d/.

In fact, the non-raising and non-palatalization present in the Curitiba dialect exclude it from being considered part of a Brazilian standard pronunciation (Elia 1979). However, the dialect native to Curitiba is perceived as more prestigious than the Interior dialect spoken in the West of Paraná. This is not surprising, since in Brazil rural dialects carry less relative prestige than urban ones (Bortoni-Ricardo 1985), and the Curitiba dialect is the least remote urban dialect to the Interior people. However, it is less prestigious than the Rio de Janeiro dialect, arguably the most prestigious BP dialect, which is one of the two standard dialects spoken on TV and considered the precursor of a standard variety of Brazilian Portuguese.

3.1 Initial Hypotheses

In regard to the Curitiba dialect acquisition by the various groups, the following hypotheses were established :

- A. Native Curitiba speakers would show 0% raising of final non-stressed /e/ and 0% palatalization of /t/ and /d/;
- B. Due to the high prestige of their native dialect, Rio de Janeiro speakers who relocated to Curitiba would still raise final /e/ and palatalize /t/ and /d/ to a great extent, showing percentages close to a 100% raising and palatalization;

- C. Interior speakers whose less prestigious native dialect raises final /e/ and palatalizes /t/ and /d/ to a great extent would slowly start to replace raising by non-raising in order to more closely approximate the Curitiba dialect. Moreover, as an immigrant's length of residence in Curitiba progresses, the rate at which they raise should gradually converge to the raising rate of native Curitiba speech.
- D. Speakers from Other Raising areas of Brazil would somewhat accommodate to the Curitiba dialect, not maintaining so much of their original raising as the more prestigious Rio de Janeiro speakers but not assimilating as much as the Interior speakers who moved to Curitiba.

	Prestige	Original Raising and Palatalization	Hypothesis for Raising and Palatalization
Native Curitiba	Reference	0%	Remains close to 0%
Rio → Curitiba	Highest	100%	Remains close to 100%
Other → Curitiba	High	50-100%	Lowers but still present
Interior → Curitiba	Lower	<50%	Lowers greatly to follow Curitiba pattern

Table 1: Initial Hypotheses

3.2 Methodology

Recorded interviews with a total of 79 informants were conducted, of which 41 were used in this study: 38 as individual interviews and a group interview with 3 girls. The choice to interview only female speakers was made because of solidarity with the interviewer and in order to avoid gender-derived speech variation. The speakers are residents of Curitiba, either natively or having moved to the city at some point during their lives. The distribution for the migrant speakers in the sample is as follows: Rio de Janeiro (with 10 speakers), the Interior of the State of Paraná (11 speakers), or Other areas of Brazil (4 speakers originally from Brasília, Campo Grande, Corumbá and São Luís do Maranhão, respectively). As a control group for the target dialect, a group of 16 girls from Curitiba was utilized.

The speakers' ages ranged from ten to 22 years and they were divided into three social classes: Lower, Middle and Upper Middle. Due to the fact that 40 of the speakers were students and dependent on their parents, I had to rely on information given about the neighborhood in which they lived, the school they attended and the number of cars their family possessed in order to assess their socio-economic status. The accuracy of this classification based on the author's native intuition was verified by three different people who are native to Curitiba.

3.3 Interview

The interviews took place in an informal setting either at the informant's or a friend's home or in a separate room in one of the schools that participated in the study. The length of the recordings varied from 15 to 30 minutes, with realization of the phonological features under study ranging from 28 to 238 instances, with an average of 90 tokens per interview. All of the informants were interviewed by the author, a middle-class woman who speaks Portuguese natively with a Curitiba dialect. Each interview followed the same format: a set of Regional Words, in which the girl was asked to identify objects and photographs, in order to elicit either the Curitiba lexical variety or a standard form of the word; a Reading Passage with 36 environments for raising and palatalization;⁴ a Semantic Differentiation task in which each informant had to state differences and similarities between two words, with at least one containing the phonological features under study; and a Spontaneous Conversation part in which demographic data was collected.

3.4 Data

A total of 3,676 tokens were collected from the interviews, all of which were used for analysis. Statistical analysis was accomplished using GOLDVARB Version 2.0 for Macintosh. The dependent factor is whether or not the final /e/ is raised and surfaces as /i/ and triggers palatalization of proceeding /t/ and /d/.

In addition, twelve independent factor groups were tested: eight for extralinguistic variables including informant's home, father's home, mother's home, social class, age, time in Curitiba, age when moved to Curitiba, friend of the author's and four linguistic variables including task, word type, previous token, and following environment. The percentage results presented

⁴Some of the younger informants who had difficulty reading were asked to stop halfway through the reading passage.

were obtained by a Varbrul Binomial run, and the probabilities derived from a Binomial Step-up/Step-down run.

4 Discussion

Only two of the extralinguistic factors will be discussed here: girls' home and their parents' home in regard to raising and palatalization.

4.1 Home

According to their home of origin (Curitiba (16 speakers), Rio de Janeiro (10 speakers), Interior (11 speakers), and Other raising and palatalization areas (4 speakers), the rate and relative weight of raising and palatalization can be seen in Table 2 as well as in Figure 1: Raising/Palatalization vs. Home below.

Place of origin	[i] + Palat.	N	% of Total	Prob.
<i>Curitiba</i>	26%	1045	28%	0.29
<i>Rio de Janeiro</i>	87%	976	27%	0.76
<i>Interior</i>	43%	1361	37%	0.40
<i>Other raising</i>	68%	294	8%	0.73
<i>Total</i>	52%	3676	100%	

Table 2: Home $\times$ Raising/Palatalization

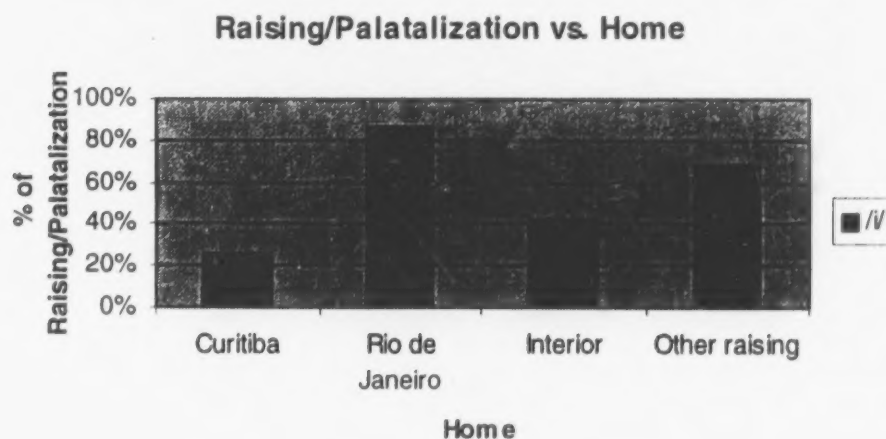


Figure 1: Percent of Raising/Palatalization $\times$ Home

While the percentage of raising in Curitiba is higher than expected, these figures reflect a continuum in regard to raising and palatalization in the four groups: Rio de Janeiro > Other raising > Interior > Curitiba, which corresponds to the hypotheses presented in Table 1.

4.2 Parents' Home

Some of the Curitiba speakers show a surprisingly high percentage of raising and palatalization (70%, 78% and 81%), and it became important to assess if the origin of parents has an effect on those features of the girls' speech.

Table 3 summarizes the findings in this respect. Other raising cities include any city in the Interior, in Rio Grande do Sul and in Northern Brazil. Other non-raising cities include two cities in the Interior of Paraná whose dialect is similar to that of Curitiba (Irati and Guarapuava) as well as cities in the Interior of Santa Catarina State.

	Curitiba	Rio de Janeiro	Interior	Other Raising	Other Non-Raising
	% of /i/ and Palat.	% of /i/ and Palat.	% of /i/ and Palat.	% of /i/ and Palat.	% of /i/ and Palat.
Father's origin	26%	83%	34%	54%	35%
N	153/578	693/830	155/458	767/1418	138/392
Mother's origin	25%	83%	51%	64%	24%
N	180/725	735/889	255/499	567/881	149/615

Table 3: Effect of Parents' Dialect on Raising and Palatalization by Native Curitiba Speakers

When parents are from Curitiba, the percentage of raising and palatalization is close to the baseline of 28% for Curitiba speakers. When either parent is from Rio de Janeiro, the percent raising is high. A mother from the Interior or from an other raising area influences raising and palatalization more than a father from either area. The mothers from these regions may already perceive that raising and palatalizing are overall prestigious features in the country and therefore pass those features on. Mothers from Other non-raising areas have the lowest effect of all and appear to be discouraging raising more than fathers who come from those same regions.

The role of parental influence in raising and palatalization exceeded my expectations. Girls whose parents are from Curitiba show a very low prob-

ability of raising and palatalization (0.26 and 0.28, compared to 0.29 overall). On the other hand, parents from Rio whose dialect is more prestigious and who raise and palatalize to a great extent greatly affect the amount of raising and palatalization among all groups of girls, regardless of their place of origin. Parents who, with regard to prestige, speak in-between dialects (Interior, Other raising and Other non-raising) seem to have less of an effect on the amount of raising realized by their daughters. These results seem to indicate that pressure from within a family with regard to accommodating to the most prestigious dialect present within the home has a stronger effect than outside peer pressure.

Relative prestige of raising and palatalizing in the parents' dialect seems to play an important role in influencing the speech of their daughters. The initial hypotheses with regard to the ranking of geographic area with respect to relative prestige is supported by these findings with regard to parents' place of origin and replicate the same prestige scale: Rio de Janeiro > Other raising > Interior > Other non-raising > Curitiba.

5 Conclusion

While elsewhere (Surek-Clark 1998) I have applied Chamber's Eight Rules of Dialect Acquisition (1992) to a larger sample who spoke a language other than English, the results reported in this paper focus on the importance of relative dialect prestige in dialect acquisition. My study corroborates Payne's on the acquisition of the Philadelphia short *a* pattern: only native girls with one parent from Curitiba are able to fully acquire the native overall pattern of non-raising and non-palatalization present in Curitiba. This leads to the unexpected indication that prestige also seems to strongly influence native dialect acquisition within the home, as demonstrated by the low usage rate of non-standard and less prestigious phonological features by native Curitiba speakers whose parents come from Rio de Janeiro.

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Final Extrametricality in Latin and Manam

Eugene Buckley

1 Introduction

Extrametricality has played an important role in metrical theory since its beginnings (cf. Liberman and Prince 1977), but its formal representation has been quite varied. Examples of its application to syllables range from a simple diacritic on the syllable (Hayes 1979, 1981) to exclusion of that syllable and its segmental content from the domain of rule application (Inkelas 1989). In the extended bracketed grids theory of Idsardi (1992), extrametricality results from the insertion of a foot edge that leads to exclusion of a syllable from foot structure. While this approach is appealing in its elegance, I argue that it cannot account adequately for the interaction of extrametricality with quantity sensitivity.

The argument is based on two languages with the same foot structure—moraaic trochees constructed at the right edge of the word—and similar, but importantly distinct, roles for extrametricality. Section 2 outlines Latin stress and extrametricality and its theoretical analysis, while section 3 demonstrates problems that this analysis encounters in treating the similar facts in Manam. (The discussion is restricted to primary stress.) Section 4 shows that in Optimality Theory a unified and principled treatment of the two languages is easily available.

2 Latin

Idsardi (1992) and Halle and Idsardi (1995) develop a theory of metrical structure in which the heads and edges of feet are sufficient to determine the locations of metrical prominences, regardless of whether a particular head has both a left and right boundary present in the representation. For example, a basic rule type is the Edge Marking Parameter, which inserts a foot edge (indicated by a parenthesis) before or after the first or last syllable of a string. In their analysis of Latin, Halle and Idsardi (1995) make use of the RLR setting of this parameter (items in bold are language-specific settings of elements subject to crosslinguistic variation).

- (1) **EDGE MARKING PARAMETER:** Place a *right* parenthesis to the *left* of the *rightmost* element in the string.

This rule accounts for the well known fact that final syllables are ignored in Latin stress placement. In the diacritic approach adopted by Hayes (1995), angled brackets indicate that the last syllable is ignored by foot construction (here, moraic trochees).

- (2) a. re(prími)<tur> 'it is held back'
 b. repri(mún)<tur> 'they are held back'

For Halle and Idsardi, application of Edge:RLR in (1) to these words accomplishes a similar task but has the advantage of using the basic notational vocabulary of the stress system—i.e., a foot edge—rather than an arbitrary diacritic. The inserted boundary essentially prespecifies a foot before the final syllable, without marking the syllable itself in any way.

- (3) x x x) x x x x) x
 re pri mi tur re pri mun tur

Subsequent rules respect this foot boundary. For example, Iterative Constituent Construction (ICC) groups stressable elements into pairs.

- (4) ITERATIVE CONSTITUENT CONSTRUCTION: Insert a *left* boundary for each pair of elements.

ICC:L would normally place a left foot boundary two syllables before the right edge of the word, giving the effect of a binary foot. (Since it inserts a left boundary, it scans in a leftward direction.) But in (3), since the final syllable is already excluded from any preceding constituent, the new foot boundary is placed two syllables before the existing boundary.

- (5) x (x x) x * x x (x) x
 re prí mi tur re pri mí tur

An important complication arises when we consider heavy syllables. The reason (2b) has penultimate stress is that the penult is closed and heavy, attracting the stress. This generalization is captured by the Syllable Boundary Projection Parameter.

- (6) SYLLABLE BOUNDARY PROJECTION PARAMETER: Project the *left* boundary of a *heavy syllable* onto line 0.

As formalized for Latin, this rule inserts a left parenthesis before the heavy penult of *reprimuntur* in (3).

- (7) x x (x) x
 re pri mún tur

ICC is not relevant to main stress in a word like this, since the left boundary has already been supplied by reference to the heavy syllable, not by grouping two syllables together. But notice that no left foot edge has been inserted before the final syllable /tur/ in (7), even though it is heavy; such an outcome must be ruled out to prevent **reprimuntúr*. (Recall that only one foot edge is necessary to establish a stress.) The same is true for *reprímitur*, which has the same final syllable.

- (8) x x x)(x x x (x) (x
 *re pri mi túr *re pri mun túr

Because extrametricality is here not formalized as a fact about the final syllable, but rather is just an inserted foot edge, the outcomes in (8) are entirely plausible.

To prevent the incorrect results in (8), Halle and Idsardi (1995) make use of an *Avoid* constraint on the application of Syllable Boundary Projection; it prevents the final syllable from starting a foot.

- (9) Avoid (x#

This constraint ensures that only a non-final heavy syllable will undergo Syllable Boundary Projection, and the forms in (8) will not be generated.¹

Already the need for this constraint lessens the elegance of the approach, but there is an additional problem: as it stands, the analysis will not work for monosyllables.

- (10) mé: 'me (acc./abl.)'
 cór 'heart (nom./acc. sg.)'

¹In the Halle-Idsardi framework, *Avoid* constraints block the application of specific rules; the relevant rule in all cases discussed here is Syllable Boundary Projection (6).

ICC is irrelevant here because that rule requires at least two syllables (4). All monosyllables in Latin are heavy, however, and we can make use of Syllable Boundary Projection to assign stresses to such words—except that the constraint formulated in (9) will block its application here, just as in any final syllable.

To remedy this situation, Halle and Idsardi modify the constraint so that it includes a preceding grid mark as well.

- (11) Avoid $x(x\#$

Naturally this revised constraint will not prevent Syllable Boundary Projection in a representation that contains a single grid mark.

- | | | |
|------|------------|-----------|
| (12) | (x
mé: | (x
cór |
|------|------------|-----------|

Thus it is possible to accommodate the Latin facts, but at the price of the rather complex and ad hoc constraint in (11). A more important difficulty for the general theory is that the solution has empirical problems when placed in crosslinguistic context.

3 Manam

I turn now to a discussion of final-syllable extrametricality in Manam, an Oceanic Austronesian language of Papua New Guinea (Lichtenberk 1983). Manam has the same basic foot structure as Latin—in traditional terms, quantity-sensitive trochees built from the right edge of the word. In the normal case, however, the final syllable is not extrametrical, so main stress falls on the last syllable if heavy (13a), otherwise the penult (b).

- | | | | |
|------|----|--|---|
| (13) | a. | i-maŋím
ta-ʔabún
u-ʔán | ‘it is sour’
‘we will gather them’
‘I ate them’ |
| | b. | wabúbu
ruaŋá-gu
ʔu-lele-ʔáma
ʔanán-da | ‘night’
‘my friend’
‘you looked for us’
‘ours’ |

Any member of the set of "AP" suffixes (underlined here) induces a pattern precisely like the Latin case: stress on a heavy penult (14a), otherwise the antepenult (b).

- | | | | |
|------|----|-------------------|----------------------|
| (14) | a. | i-ʔínt- <u>a</u> | 's/he pinched me' |
| | | matá-n- <u>lo</u> | 'in your eye' |
| | b. | tína- <u>ma</u> | 'our mother' |
| | | mánam- <u>o</u> | 'on Manam island' |
| | | i-léle- <u>a</u> | 's/he looked for me' |

A conventional analysis is to treat the final syllable as extrametrical, by a special rule that is triggered by these suffixes (cf. Halle and Kenstowicz 1991). For Idsardi and Halle, an interesting alternative is possible: the suffixes have an underlying grid mark with a right boundary preceding it (Bill Idsardi, p.c.).

- | | | |
|------|-----|-----|
| (15) |) x |) x |
| | ma | lo |

Morpheme concatenation, plus regular projection of grid marks, yields the following initial representations for two examples in (14). Notice that this is parallel to the output of Edge:RLR in Latin (3), and could equivalently be generated by idiosyncratic (morphologically triggered) application of the rule in Manam.

- | | | |
|------|----------|-----------|
| (16) | x x) x | x x) x |
| | tí na ma | ma tán lo |

Of these two words, Syllable Boundary Projection (to the left of a heavy syllable) has an effect only for *matánlo*, where it creates a nonbranching foot (cf. (7)). In the absence of a heavy penult, e.g. *tínama*, antepenultimate stress is generated by ICC as in Latin (5).

- | | | |
|------|----------|-----------|
| (17) | (x x) x | x (x) x |
| | tí na ma | ma tán lo |

The crucial difference between Latin and Manam is that, as seen in (13a), Manam normally assigns stress to a heavy final syllable. None of the AP suffixes is heavy, but we do find a heavy extrametrical syllable in the case of

the zero AP suffix that marks third-person singular possession (in a noun) or object (in a verb). Since there is no segmental content in the suffix, its only exponence is the shift in stress, even when the final syllable is heavy, as in (18c,d).

- | | | | |
|------|----|----------|-----------------------|
| (18) | a. | paŋána | 'head' |
| | | pána<na> | 'his/her head' |
| | b. | balígo | 'grass skirt' |
| | | báli<go> | 'his/her grass skirt' |
| | c. | da-ʔáŋ | 'they will eat them' |
| | | dá-<ʔaŋ> | 'they will eat it' |
| | d. | u-zém | 'I chewed them' |
| | | ú-<zem> | 'I chewed it' |

As with the other AP suffixes, a right foot boundary before the final syllable can be achieved by morphologically sensitive application of Edge:RLR, but the following underlying representation is also possible in this framework: grid information without any segmental content.

- (19)) x

Whatever its source, we need the following minimal initial contrast for (18c).

- | | | | | |
|------|---------------|--------|-----------------|--------|
| (20) | <i>plural</i> | x x | <i>singular</i> | x) x |
| | | da ʔaŋ | | da ʔaŋ |

Here lies the problem. In order to have final stress on the plural *daʔáŋ*—as well as any other ordinary word ending in a heavy syllable (13a)—constraint (9) or (11) cannot be active in Manam. But without such a restriction, we predict the following outputs of Syllable Boundary Projection.

- | | | | | |
|------|---------------|--------|-----------------|---------|
| (21) | <i>plural</i> | x (x | <i>singular</i> | * x) (x |
| | | da ʔáŋ | | da ʔáŋ |

This problem arises exactly because in this approach the final syllable is not specifically excluded from the domain of stress: an underlying or inserted right foot boundary is not sufficient to prevent incorrect creation of a final foot. An alternative to the Latin analysis is a constraint of the type *Avoid)(*, which will rule out the incorrect singular form in (21). In addition to its ad

hoc nature, however, this move results in quite distinct enforcement of final extrametricality in Latin and Manam, despite the intuitive identity of the facts. It may be possible to use this constraint in Latin rather than (11), but a more fundamental problem for either language is that *Avoid*)(fails to capture the right insight: The problem with **reprimuntúr* is not that it violates some kind of foot clash, but that it fails to respect the extrametricality of the final syllable.

Thus while the use of the Edge Marking Parameter (or underlying structure with a similar effect) to generate the effect of extrametricality works well for simple cases, it leads to complications in Latin and to explanatory inadequacy in Manam.

4 Anti-alignment

There are various other approaches to extrametricality that can account for both the Latin and the Manam facts in a unified fashion. A diacritic approach (cf. Hayes 1981, 1995, Halle and Vergnaud 1987, Halle and Kenstowicz 1991) avoids the problem just noted, but suffers from an ad hoc formalism. I sketch here a solution for Manam that has the elegance of Halle and Idsardi's foot boundary plus the empirical power to exclude the final syllable from foot structure—namely, foot alignment in Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1993). Here I assume familiarity with the framework; see Buckley (1998) for a more comprehensive treatment of Manam stress in OT.²

In the normal case, the foot marking main stress in Manam will be aligned with the right edge of the word, yielding the pattern in (13); thus the basic constraint is ALIGNFT (22). The constraint needed for the AP suffixes is one that disallows perfect right-alignment of a foot and an AP suffix, forcing minimal displacement of the foot from absolute final position. In Buckley (1998) this is **ALIGNAP*.

- | | | |
|------|----------------------------|--|
| (22) | ALIGNFT
<i>*ALIGNAP</i> | AlignR(Foot; PrWd)
<i>*AlignR</i> (AP suffix; Foot) |
|------|----------------------------|--|

Ranked **ALIGNAP* » ALIGNFT, these constraints generate the following results when combined with other well known constraints such as FTBIN and

² The alignment approach to Manam clitic stress in Buckley (1998) can also be applied to the Latin clitic facts assumed by Halle and Idsardi: the main stress is simply aligned with the left edge of the clitic (*liminá=que*, *ubí=libet*, *quá:=propter*).

PARSESYL (see Buckley 1998). The right edge of the AP suffix is marked by a square bracket.

(23)	/tina-ma/	*ALIGNAP	FTBIN	ALIGNFT
a.	 (tína)ma]			
b.	ti(náma)]	*!		

This analysis extends easily to the case of a zero AP suffix. Since there is no segmental content intervening between the end of the root and the end of the AP suffix, they are indistinguishable on the timeline; any foot that right-aligns with the root violates *ALIGNAP.

(24)	/da-ʔaŋ-Ø/	*ALIGNAP	FTBIN	ALIGNFT
a.	 (dá)ʔaŋ]		*	
b.	da(ʔáŋ)]	*!		
c.	(dà)(ʔáŋ)]	*!	*	

The essential point to be drawn from these facts is that the constraint *ALIGNAP, which replaces an extrametricality diacritic, specifically refers to whether the final syllable of the relevant word ends in a foot. The Halle and Idsardi approach to extrametricality, on the other hand, is silent on this point. Insertion (or prespecification) of a foot boundary is really about *one* foot, the one preceding the final syllable. But what the theory must do is prevent the occurrence of *any* foot on the final syllable. An (anti-) alignment constraint does precisely this, while maintaining the insight that syllable extrametricality is actually a fact about feet, rather than a diacritic property of a syllable.

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Yoruba Vowel Elision and Compounding*

Amanda Seidl

1 Introduction

This paper examines two strategies for eliminating vowels in hiatus in Yoruba: the elision of the first vowel in hiatus (First Vowel Elision) and the absence of the second vowel in hiatus (Second Vowel Absence).¹ I argue that First Vowel Elision is a post-lexical phonological rule, and that Second Vowel Absence, while it appears to be a phonological process, is in fact the result of the non-application of a certain morphological process in these forms.

First Vowel Elision (FVE) looks as if it is a purely post-lexical phonological rule because it occurs not just between verbs and their complements, but in a range of environments which are not subject to a uniform characterization (1a-1d). We will also see in section 2.1 that FVE occurs across clausal boundaries.

- | | | |
|---------------------|---------|------------------|
| (1) a. gbé odó | → gbódó | <i>verb+noun</i> |
| lift mortar | | |
| 'lift-mortar' | | |
| b. dé oko | → dóko | <i>prep+noun</i> |
| to farm | | |
| 'to the farm' | | |
| c. pé ọmọ | → pọmọ | <i>comp+noun</i> |
| that child | | |
| 'that the child...' | | |
| d. fọ aṣẹ | → fapẹ | <i>verb+noun</i> |
| wash pot | | |
| 'wash-pot' | | |

Second Vowel Absence (SVA), on the other hand, occurs in more restricted environments. It occurs between nouns in noun-noun compounds and between a certain set of verbs and their complements (2a-2b).

*The work in this paper is an outgrowth of a field methods class. Many thanks are due to the language experts who participated, Yiwola Awcyale (Igbomina data) and Mojisola (Ikale data). I would also like to thank Mark Liberman and Rolf Noyer for comments on an earlier version of this paper.

¹This is traditionally called Second Vowel Elision, but I will refer to it as Second Vowel Absence because on my analysis this vowel is never inserted, hence it is absent. I will explain this part of the analysis in detail in section 4.

- (2) a. $\text{om}\text{ò} \text{ ad}\text{iye} \rightarrow \text{om}\text{òdiye}$ *noun+noun*
 child chicken
 'chick'
- b. $\text{wí} \quad \text{ejó} \rightarrow \text{wíjò}$ *verb+noun*
 complain case
 'argue'

Earlier studies have attempted to characterize the rules for vowels in hiatus using SPE rules (Bamgboṣe 1966), lexical phonology (Akinlabi and Oye-bade 1987), autosegmental phonology (Pulleyblank 1988), and direct reference to the syntax (Awoyale 1995). However, all of these approaches have difficulty both in accounting for exceptions to their rules and in describing the SVA contractions, which behave distinctly. Awoyale's approach does not have these problems, but his account requires a large degree of direct reference to the syntax which I argue is not necessary.

In this paper I will show that FVE is a late phonological rule and requires no reference to the syntax; FVE is contraction. I will present Optimality Theoretic constraints which account for all cases of FVE.

I propose that all instances of SVA in verb-noun forms are instances of compounding and that the nouns in SVA forms are incorporated (Baker 1988).

I argue that SVA forms act differently than FVE forms phonologically because they are morphologically distinct: FVE forms, but not SVA forms, contain the non-inflected root form of the noun. Thus, in contrast to previous accounts, this account is able to account for the SVA forms without direct reference to the syntax.

2 First Vowel Elision Forms

In Yoruba, words which end in vowels can combine through FVE with words that begin in vowels. This rule distinguishes between different vowels, with high vowels being treated in a special way. A few examples of the many environments where this is possible can be seen in (3-6).

Preposition+noun

- (3) $\text{dé} \text{ oko} \rightarrow \text{dóko}$
 to farm
 'to the farm'

Verb+noun

- (4) *râ eja* → *rèja*
 buy fish
 'buy the fish'

Complementizer+noun

- (5) *pé ọmọ* → *pọmọ*
 that child
 'that the child...'

Verb+adjective+noun

- (6) *rí agbaja* → *rágbaja*
 see big-dog
 'saw big dog'

2.1 FVE is Not Sensitive to the Lexical Category of the First Word

Given the examples in (3-6) it seems that the rules of FVE are insensitive to the lexical category of the preceding form. The first vowel deletes on the word preceding a noun, regardless of whether this word is a preposition, a complementizer, a verb or an adjective.

2.2 FVE is Insensitive to Maximal Projection Boundaries

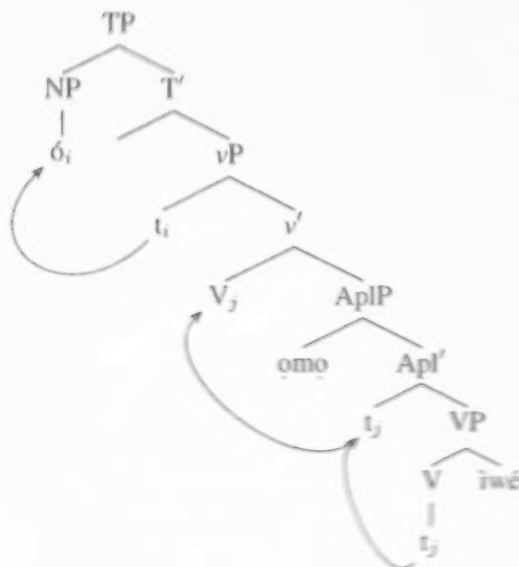
In addition, FVE seems insensitive to maximal projection boundaries. For example, FVE can occur between verbs and either direct, (7a), or indirect objects, (7b).

- (7) a. *ó fú ìwé ní ọmọ* → *ó fúwè ní ọmọ*
 3s gave book to child
 'he gave the book to the child'
- b. *ó fú ọmọ níwè* → *ó fọmọ níwè*
 3s gave child to-book
 'he gave the child the book'.

If we assume that the indirect object *ọmọ* is generated in the specifier of the Applicative Phrase (Marantz 1993), then the verb must raise to a position above the Applicative Phrase in order to produce the word order we find in

(7b). And if the verb is above the Applicative Phrase, then it follows that FVE operates across maximal projections, since in (7b) there is contraction of the verb and its indirect object. Thus FVE occurs across at least AplP, as shown in (8). If the verb moves onwards to Tense, then FVE will cross both AplP and vP.

(8)



2.3 FVE is Insensitive to Clausal Boundaries

(9) shows that FVE is also insensitive to clausal boundaries, such as CP. The verb in (9), *nī* 'to say', can appear without an overt complementizer; still, there is clearly a clause boundary between it and the noun *omo* 'child'. (Note the separate tense markers in the lower clause.) FVE nonetheless applies to combine them, indicating that this process can cross clause boundaries.²

- (9) *ó nī* [_{CP} [*omo ma jẹ ẹja*]] → *ó lomo jeja*.
 3s said child FUT eat fish
 'He said the child ate the fish'

From this example we also learn that FVE is not sensitive to the phonological phrase, as defined by Selkirk's (1986) end-based account of the phonological phrase. In an end-based theory, phonological phrases are constructed by grouping all words into a phrase until the end of an X^{max} . If FVE were

²In Yoruba [n] and [ɲ] are argued to be allophones of the same phoneme, [n] only occurs when it appears in front of a nasalized vowel and [ɲ] occurs elsewhere.

bounded by the edges of the phonological phrase, hence by the edges of X^{max} , then it ought to be blocked by clausal boundaries. But (9) shows that it is not.

2.4 FVE is Blocked by Intonational Phrase Boundaries

We have just seen that FVE can apply across a clause boundary. It does not, however, apply across the boundary of an adjunct clause, as demonstrated in (10).

- (10) a. ngbo John je ọmọ jó.
 while John eat child danced
 'While John ate the child danced'
- b. *ngbo John jomọ jó
 while John eat-child danced

I argue that this is because, cross-linguistically, clausal adjuncts are intonational phrase boundaries, as argued by Nespor and Vogel (1986). Vowel elision/contraction cannot occur across intonational phrase boundaries.³

Given the evidence in sections 2.1-2.4, we can see that deletion of the first vowel in hiatus (FVE) is a phonological rule which occurs across several types of syntactic boundaries between words and is only blocked by intonational phrase boundaries.

2.5 The Special Status of [i]

In the cases we have examined thus far, the first vowel has always deleted, but this is not always the case. When one of the vowels in hiatus is [i], it is always deleted, regardless of whether it is the first or the second vowel. For example, in (11a) the first vowel is not deleted because the second vowel is [i]. The same is true for (11b).

- (11) a. gbé inọ → gbénọ *Bamgbose (1966)*
 take fire
 'take the fire'
- b. ka ìwé → kàwé
 read book
 'read a book'

The deletion of [i] also occurs regardless of the syntactic status of the following or preceding forms.

³In support of this argument, we also do not find ATR harmony across adjuncts.

2.6 Summary of FVE Up to This Point

We can summarize FVE at this point by stating that:

- (i) Deletion of the first vowel in hiatus (FVE) is a phonological rule which occurs between words across several types of syntactic boundaries and is only blocked by intonational phrase boundaries.
- (ii) The vowel [i] always deletes regardless of whether it is the first or second vowel.

(12) defines FVE in light of these observations.

- (12) **First Vowel Elision:** The first vowel deletes *except* when the second vowel is [i]. This process is blocked only by intonational phrase boundaries.

In the next section I argue that FVE occurs because Yoruba has a ranking of ONSET over MAX-IO. Because of this ranking Yoruba prefers deletion to syllables without an onset, thus causing FVE.

3 Phonological Constraints for Yoruba FVE Contractions

The ranking of constraints in Yoruba captures the causes of First Vowel Elision. (The tonal output can also be explained within OT, but I will not show this here.) In this section I present an Optimality-Theoretic analysis of Yoruba vowel elision.

The constraints below operate within a certain domain. They will not operate across clausal adjuncts, which always define a separate intonational phrase, but they will operate on all adjacent words which do not begin or end intonational phrases.⁴

3.1 Crucial Constraints and Rankings

Yoruba can have CV, V, or syllabic nasals as syllables; however, we find vowel deletion in CV.V.CV words, indicating that Yoruba prefers deletion to syllables

⁴We would like to know if these constraints would operate between e.g. Aux+verbs and Subj+verbs, but it is impossible to tell because verbs always begin with consonants and are thus not candidates for elision.

without an onset (13).

(13) ONSET: Syllables have onsets.

MAX-IO must rank below ONSET in Yoruba because segments are deleted to repair ONSET violations (15). Thus we rank ONSET higher than MAX-IO (14), which prohibits deletion.

(14) MAX-IO: Every input segment has a correspondent in the output.

(15)

	/dé oko/	ONSET	MAX-IO
☞	a. dóko		*
	b. dé oko	*!	

It is the ranking of ONSET >> MAX-IO that motivates elision in (16-17).⁵

(16) rà ɛja → rèja
buy fish
'buy the fish'

(17) tèlé ɛja → tèléja
follow fish
'follow the fish'

Elision is blocked in forms without ONSET violations, (18). This shows us that FVE is not an effect of a constraint on the size of minimal words.

(18) ra bóbalò → ra bóbalò
buy bible

There are no diphthongs in Yoruba (Bamgboṣe 1966). Thus, in order for a CVVCV word to have an onset the two vowels cannot be syllabified as a diphthong (20). The constraint which prevents this is *DIPH (19).

(19) *DIPH: There are no diphthongs.

I argue that *DIPH is undominated in Yoruba; otherwise we would get forms such as the one in (20) in order to repair ONSET violations.⁶

⁵We know that it is ONSET and not FTBIN that motivates elisions because, in (17), FVE applies despite the concomitant creation of a non-binary foot where there were none in the input, in violation of FTBIN.

⁶*DIPH is also in an important constraint in that it triggers assimilation between nouns which are genetical. Thus between a noun and a possessor there is a different constraint domain which ranks MAX-IO (14) higher than in the elided forms we are discussing in this paper.

- (20) rà eja → *ràɛ.ja
 buy fish

Because [i] in Yoruba acts differently than other vowels, we need a constraint which accounts for this unusual behavior. Traditionally, [i] in Yoruba is argued to be underspecified (Pulleyblank 1988).⁷ Pulleyblank argues that [i] is deleted more readily than other vowels because it is underspecified. [u] is also deleted over other vowels; thus [u] could be argued to be only partially specified.

Because I am providing an Optimality-Theoretic account of FVE, the account must follow the principle of *richness of the base* (Prince and Smolensky 1993). The principle of *richness of the base* expresses a generalization that in OT all cross-linguistic variation depends of the ranking of constraints rather than differences in the inputs of languages. That is, underlyingly, no vowel can be guaranteed to be underspecified.

Thus, we cannot argue that high vowels ([i] and [u]) are deleted simply because they are impoverished of features; then we would have to argue that [i] and [u] are underspecified in all languages. Rather, I argue that [i] and [u] are deleted because of a ranked constraint which penalizes certain vowels, namely those which are less sonorous (or high). The constraint is stated in (21).

- (21) *HIGH-V: A segment less sonorous than a mid vowel is non-nuclear (in the spirit of Prince and Smolensky (1993).

Thus, [i] and [u] will always be deleted over other vowels.⁸ The constraint I propose here (*HIGH-V) is similar to the Nuclear Harmony Constraint proposed in Prince and Smolensky (1993). On my account, because high vowels are crosslinguistically less sonorous than low or mid vowels, any high vowel creates a violation of *HIGH-V. Because [u] is not deleted when it occurs with [i] (see (23) below, *múwé* 'make book') there is an additional constraint which causes [u] to be preferred over [i]. This constraint is *HiFRONT (22).

- (22) *HiFRONT: A segment less sonorous than a mid vowel and less sonorous than a central vowel is non-nuclear.

⁷Pulleyblank (1988) also shows that [i] is the vowel epenthesized to break up consonant clusters in loan words.

⁸This does not, however, explain why [i] is the epenthetic vowel in Yoruba. If high vowels are dispreferred in general we would not expect them to show up to break up clusters in loan words. This is a problem for further research, beyond the scope of this paper.

Because the vowel [u] does not violate *HIFRONT, but [i] does, it is more expensive to maintain [i] in the output.

The tableau in (23) exemplifies the interaction between these constraints. In (23) we see that the candidate with [u], candidate (a), is penalized less than the candidate with [i], candidate (b), because candidate (b) would cause more violations of *HIFRONT. Of course candidate (c) is ruled out because of a violation of the highly ranked ONSET constraint. *HIFRONT and *HIGH-V are not crucially ranked with respect to one another. MAX-IO needs to rank below all these constraints so that we always find deletion of one of the vowels in order to repair ONSET violations.

(23)

/mú ìwé/	ONSET	*HIGH-V	*HIFRONT	MAX-IO
a. múwé		*		*
b. míwé		*	*!	*!
c. mú ìwé	*!	*!	*!	

DEP-IO (24) must rank over ONSET because consonants are never epenthesized to repair ONSET violations (*múbìwé) (25).

(24) DEP-IO: Segments in the output are present in the input.

DEP-IO is not ranked with respect to *DIPH.

(25)

/mú ìwé/	DEP-IO	ONSET
a. múwé		
b. mú bìwé	*!	
c. mú ìwé		*!

In addition, there is a positional faithfulness constraint which explains why we find that the first vowel consistently elides when the two vowels in hiatus both have features which do not violate *HIGH-V or *HIFRONT, as in (26a) and (26b).

- (26) a. sọ òótọ → sòótọ
 speak truth
 'speak the truth'
 b. rọ awọ → rǎwọ
 sew leather
 'sew the leather'

This constraint is MAX-NOUN (27). I propose that, in Yoruba, faithfulness to the initial segment of a noun ranks higher than other faithfulness constraints.

(27) MAX-NOUN: A segment of a noun in the input is present in the output.⁹

Tableau (28) shows how MAX-NOUN forces elision of the first vowel, because deletion of the noun's segments is penalized by MAX-NOUN, but deletion of another constituent's segments is only penalized by the low ranked MAX-IO.

(28)

/sọ òótótó/	ONSET	MAX-NOUN	MAX-IO
a. sòótótó			*
b. sótótó		*!	*
c. sọ òótótó	*!		

*HIGH-V must rank higher than MAX-NOUN so that [i] is always deleted in the output regardless of whether it is the first or second vowel (29). In addition, *HIFRONT must rank over MAX-NOUN so that when [u] is the first vowel and [i] is the second vowel, [i] deletes. MAX-NOUN ranks over MAX-IO, because noun segments are always maintained over all other segments.

In (29) [i] is deleted, even though it violates MAX-NOUN. However, if two vowels are equally sonorous, as in (30), the ranking of constraints will force the first vowel to delete.

(29)

/ka ìwé/	ONSET	*HIGH-V	MAX-NOUN	MAX-IO
a. kàwé			*	*
b. kìwé		*!		*
c. ka ìwé	*!	*		

The winning candidate (a), *robè* 'buy soup', violates MAX-IO, but since it is ranked so low it is not crucial. Candidate (b) is ruled out by a violation of *DIPH. Candidate (c) is ruled out by a violation of ONSET.

In (30) IDENT-F accounts for the lack of coalescence (candidate (e)) because the candidate with coalescence does not maintain featural specification from the input to the output.¹⁰ We also see that (f) is ruled out because it cru-

⁹This constraint is similar in flavor to noun faithfulness constraints proposed in Smith (1997); here Smith discusses evidence from Japanese where certain contrasts exist in nouns that do not in other lexical categories. It is also similar to the positional faithfulness constraints proposed by Casali (1997).

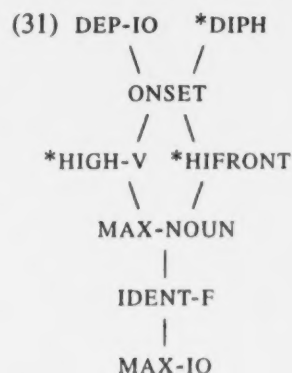
¹⁰UNIFORMITY could also be used to account to rule out the coalescence candidate.

cially violates MAX-NOUN.

(30)

/ra ₁ o ₂ bè/	DEP-IO	*DIPH	ONSET	MAX-NOUN	IDENT-F	MAX-IO
a. r o bè						*
b. ra o bè		*!				
c. ra o b è			*!			
d. ra b o bè	*!					
e. r v _{1,2} bè					*!	*
f. ra b è				*!		*

The final hierarchy of constraints in depicted in (31).



4 Second Vowel Absence

Seemingly, the SVA forms present a counter-example to claims made in the literature on vowel elision (e.g., Casali 1997) that FVE between lexical words is universal. Casali argues that FVE is universal because, for lexical words, the word-initial position is stronger than the word-final one. Much work on positional faithfulness concerning various processes in phonology supports this claim (Beckman 1998).

In support of Casali (1997), I argue that Yoruba does not delete the word-initial or second vowel in SVA forms. Rather I argue that this vowel is not even present in the UR. Before I go into my analysis of these forms, let me first provide a description of the character of SVA and of the environments in which it can occur.

SVA, in contrast to FVE, seems to be sensitive to syntactic boundaries and insensitive to the status of [i] in Yoruba. We should view the insensitivity to the status of [i] as a clue that what is occurring in SVA forms is *not* phonological.

We state a generalization of where SVA occurs in (32).

- (32) **Second Vowel Absence:** The second vowel does not appear, *regardless* of whether the first or second vowel is [i] (33b). This occurs in certain morphosyntactic contexts; SVA is restricted to occurring in noun-noun compounds and between certain verbs and nouns (34a-34b).

Verb+noun

- (33) a. ó ta epo → ó tapo
3sg spill oil
'He spilled oil'
- b. ó wí ejó → ó wíjọ
he complain case
'He pleads a case'

Noun+noun

- (34) a. ọmọdé ọbìnrin → ọmọdébìnrin
little-child girl
'little girl'
- b. ọmọ ẹ̀diye → ọmọ̀diye
child chicken
'chick'

4.1 The Syntactic Status of Nouns in SVA Forms

Although nouns in the FVE verb-noun forms can be referential and definite, this is not the case for SVA forms. Compare (35a) to (35b).

- (35) a. ó ta epo → ó tapo SVA
3sg spill oil
'He spilled oil' *He spilled *the* oil
- b. rà ẹ̀ja → rèja FVE
buy fish
'buy a/the fish'

In addition, many pairs which undergo SVA are semantically distinct from those that undergo FVE in that they often have idiomatic or non-compositional meaning. As shown in (36), we find an idiomatic meaning for the verb 'remove' and the noun 'foot' when the second vowel is elided, but a compositional meaning when the first vowel is elided.

(36)

2 words	Std Yoruba	Semantics	Phonology	English
gbé ẹ̀sẹ̀	gbésẹ̀	compositional	FVE	remove foot
gbé ẹ̀sẹ̀	gbésẹ̀	idiomatic	SVA	walk fast
fẹ̀ ọ̀rọ̀n	fórọ̀n	compositional	FVE	to want matter
fẹ̀ ọ̀rọ̀n	férọ̀n	idiomatic	SVA	to like

Table 1: SVA vs. FVE

In contrast to the SVA forms in (36), the nouns in FVE forms do not lose their syntactic status as arguments of the clause and can be referential, as in (37).

- (37) ó fú ìwé ní ọ̀mọ̀ → ó fúwè ní ọ̀mọ̀
 3s gave book to child
 'he gave the book to the child'

In addition, for FVE forms, when the verb's or another constituent's final vowel is not elided and joined with a noun it has the same meaning as when it undergoes FVE (cf. (37-38)).

- (38) ó fú ìwé ní ọ̀mọ̀
 3s gave book to child
 'he gave the book to the child'

SVA verb-noun forms however, unlike FVE ones, cannot be separated syntactically into a verb and noun that are not string-adjacent and maintain their meaning (cf. 39a-39c).

- (39) a. ẹ̀sẹ̀ ló gbé
 foot 3s remove
 'It was the foot that was removed' ('*It was walked fast')
- b. ó gbésẹ̀
 3s remove-foot
 'He walked fast'

- c. ó gbésè
 3s remove-foot
 'He removed the foot'

In (39a) we cannot get the idiomatic reading, 'it was walked fast', when the noun is fronted. The only reading possible for (39a) is the compositional reading, 'it was the foot that was removed'.

Often, however, we find compositional meaning in SVA forms (although note that the noun still cannot be definite), see (40).

- (40) ó fọ așo → ó fọșo
 3sg wash clothes
 'He washed clothes' (*'He washed *the* clothes')

I argue that even these compositional forms, like the idiomatic SVA forms, are compounds. The evidence for this argument comes from possessive constructions. Forms such as (40) (with SVA) occur when there is no overt possessor. However, in the Igbomina dialect, when there is a possessor, the first vowel elides instead of the second, resulting in the form in (41a).¹¹ In certain dialects, FVE is forced when there is an overt possessor. Furthermore, in Igbomina the form with SVA in (40) is ungrammatical with a possessor. This is exemplified in (41b). Thus it seems that although (40) is compositional it is syntactically a compound and the noun *clothing* is incorporated.

IGBOMINA

- (41) a. ó fọ așo Yiwola → ó fașo Yiwola
 3sg wash clothes Yiwola
 'He washed Yiwola's clothing'

- b. *ó fọșo Yiwola
 3sg wash-clothes Yiwola

The ungrammaticality of (41b) indicates that *așo* must not be an accessible object to be possessed in (40) but can be in (41a). Therefore I conclude that *așo* in (40) must be incorporated, because 'clothing' is not an argument but a lexically inseparable piece of the verb.¹²

¹¹This form is also possible without an overt possessor, but always implies a possessor.

¹²There are dialects (Ikale, for example) which can have a possessor with the SVA form in (40) (see (42)). If we argue that the form in (40) is always a compound then

These data from possessive constructions clearly show us that even compositional SVA forms are instances of incorporation.

Because of the factors outlined above for SVA nouns, i.e., lack of referentiality and inability to be definite, I conclude that all SVA forms are the result of incorporation (Baker 1988), whereas the FVE forms are the result of simple phonological contraction.

What is important to note from the argumentation in this section is that FVE forms act differently than SVA ones more than just phonologically. Therefore we are justified in treating them separately.

On my account SVA verb-noun pairs are formed in the same way noun-noun compounds are, namely, through being incorporated into another syntactic head. The proposal that the SVA forms are compounds explains why they undergo the same phonological rules as noun-noun compounds. It also explains their semantic behavior.

4.2 Why the Initial Vowel of a Noun is Absent when that Noun is Incorporated

Now that we have discussed the syntactic status of these nouns, I will discuss why the initial vowel of a noun is absent when that noun is incorporated.

I propose that, in Standard Yoruba, when a noun is incorporated, only a certain form of the noun is inserted, namely one without the initial vowel. This results in what appears to be the elision of the second vowel, but is in fact just the underlying absence of the noun's initial vowel.

4.2.1 A Morphological Account of SVA

The initial vowel of a noun in Yoruba is a residue of a classifier system (as mentioned in Bamgboṣe 1966). Thus the initial vowel was arguably a separate morpheme, and perhaps still is, structurally.

This prefix, or decayed class marker, can also be seen as the locus of referentiality or as a determiner. Thus it is natural that it does not appear in SVA constructions. It has long been recognized that inflectional morphology

we need to explain why *aṣo* is an accessible object in (42) in Ikale.

IKALE

- (42) ó fọṣo Yiwola (*in other dialects)
 3sg wash-clothes Yiwola
 'he washed Yiwola's clothing'

does not occur inside compounds (Kiparsky 1982). Thus, noun-initial vowels do not occur in Yoruba compounds because these markers are inflectional. Words that appear in compounds tend to be inserted without inflection.

Harris (1991) points this out for Spanish word-markers. Specifically, Harris argues that the final vowel in the Spanish nouns is a noun-word-marker (43).

- (43) a. pas-o
step-ClassI
'step'

Harris (1991)

- b. pas-a
raisin-ClassII
'raisin'

In Spanish, word-markers do not occur word-internally (Harris 1991) (see (44), where word-markers are in bold-face). Similarly, in English compounds such as *rat-catcher* are grammatical, but compounds with inflection for number such as **rats-catcher* are not grammatical.

- (44) a. lej-os
'far'

Harris (1991)

- b. lej+an-o (*lej-os+an-o)
'distant'

I propose that this initial vowel on Yoruba nouns is similar to the final vowel on Spanish nouns in that it is only added to nouns which are words or occur at the edge of an X^0 . Thus this vowel is never added to words in compounds because they are either within N or within V (45). The rule for the insertion of this vowel is stated in (45).

- (45) *noun-word-marker vowel* $\longleftrightarrow$ $_{-} [X^0]$

If the noun 'child' is underlyingly /mɔ/, the surface form ɔmɔ occurs only when the noun does not form a compound with something that precedes it. In Yoruba the gender of the noun predicts whether the noun-word-marker is realized as o-, u-, e-, a-, i-, ɛ, or ɔ-.

Because compounded forms have an incorporated noun, noun-word-markers are never inserted in the morphology because the second noun is never at the edge of an X^0 . This is exemplified in (46). Here we see that the initial vowel of a noun is only inserted at the edge of an X^0 as seen in (46b). This

form can not mean 'walk fast', but can only mean 'remove foot' because it is not a compound.

- (46) a. [X° gbé sè] → gbésè
 remove foot
 'walk fast'
- b. [X° gbé [X° ésè] → gbésè
 remove foot
 '*walk fast' (√'remove foot')

4.2.2 FVE and SVA Forms with a Following Noun

Another key difference between contractions and compounds can be seen when they are followed by another noun. In FVE forms with a following noun the extra noun is interpreted as a possessive modifying the NP, and the entire pair is an argument of the verb (47a). However, in SVA forms the verb and the first noun form a compound and the second noun is interpreted as an argument of this verbal compound (47b).

This is further evidence that SVA forms are compounds resulting from incorporation of the noun into the verbal head.

- (47) FVE:
 a. mo rí ọmọ aja → mo rọma aja
 I saw [child dog]
 'I saw the dog's child'
- SVA:
 b. ó bí ọmọ aja → ó bímọ aja
 3sg [birth child] dog
 'She have birth to a puppy'

Thus the semantic differences between FVE forms and SVA forms (lack of referentiality, inability to be possessed) are a result of the fact that SVA forms include a noun which is not a DP, but is just an N. In contrast, FVE forms combine DPs with verbs. The lack of referentiality in SVA forms on my account comes from the lack of a determiner (or the lack of a +referential determiner in the sense of Longobardi 1994). Because SVA forms, or rather their nouns, are not NPs or DPs, but merely bare nouns, they can be neither definite nor referential.

5 Conclusion

In this paper, I have argued that FVE can be accounted for purely phonologically. SVA, on the other hand, requires reference to morphological information. I have attempted to provide an account of two distinct phonological phenomena in Yoruba which also is able to explain the syntactic and semantic differences between FVE and SVA forms. In addition, this account (unlike previous accounts) is able to account for both SVA and FVE varieties of verb-noun forms without requiring the phonology to make reference to syntactic information or employing arbitrary rules.

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The Laryngeal Effect in Korean: Phonology or Phonetics?*

Eon-Suk Ko

1 Background

It is well-known that voicing distinctions in prevocalic position can affect the fundamental frequency (F0) of following vowels (Hombert 1977, Kingston & Diehl 1994, among others). Most of the literature on this issue, however, has dealt only with how the segmental effects of the binary voicing distinction between 'voiced' and 'voiceless' are different on the F0 of the following vowel. The question arises how this effect would be realized in languages like Korean where obstruents with the same place of articulation can contrast in more than binary ways.

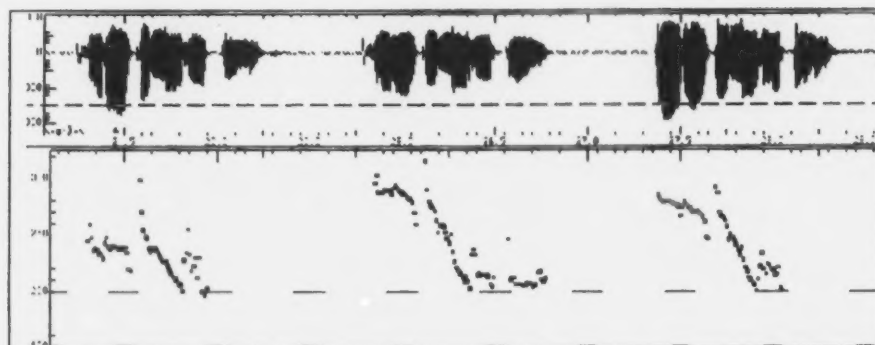
Korean obstruents are generally grouped into three series, referred to as lenis (/p, t, k, c, s/), aspirate (/p^h, t^h, k^h, c^h/) and fortis (/p', t', k', c', s'/). Since each of the consonants in these groups can cause meaning contrasts, what exactly characterizes the featural specification of these series has been an issue. Generally the lenis is considered the least marked with no laryngeal specification at the underlying level, while the aspirate and the fortis are specified with [+spread glottis] and [+constricted glottis], respectively, under the laryngeal node.¹

Korean obstruents have also been reported to influence the F0 of a following vowel (Kim 1965, Kagaya 1974, etc.). Specifically, a higher F0 is found after aspirate and tense consonants but a lower F0 after lenis consonants. The following picture illustrates these effects.

*This paper has grown out of an experiment conducted while taking Ling 521 in Spring 1998. I thank Mark Liberman, Gene Buckley, Rolf Noyer, John Kingston, Steven Bird, Kazuaki Maeda, and John Bell for their help. Usual disclaimers apply. A revised and expanded version of this paper will appear in the proceedings of the Holland Institute of Linguistics Phonology Conference 4. Readers who are interested in a more phonological approach to the prosodic prominence system of Korean are referred to Ko (1999b).

¹The fortis consonant is phonetically realized as identical as geminated lenis consonants. Therefore, it has been argued whether the Korean fortis is a geminated lenis or a singleton. Since the argument is not directly related to the issues raised in this paper, I will not discuss the nature of the fortis consonants in this paper. However, I have argued elsewhere (Ko 1999a) that the fortis series are actually geminated lenis consonants.

(1) Laryngeal effects on the F0 in Korean



[pa-lako malhay-pwa] [p^ha-lako malhay-pwa] [p^ha-lako malhay-pwa]
 ('say pa') ('say p^ha') ('say p^ha')

In a study of the prosodic system of Korean, Jun (1993) argued that this segmental effect has been phonologized to a H tone in Korean. Were this correct, the situation in Korean would be unusual. While the phonologization of F0 *depression* is cross-linguistically common, there are very few cases where *boosting* of F0 under the influence of preceding consonants has been analyzed as a phonologized effect. We should therefore be wary of accepting Jun's theory, as it posits for Korean a typologically marked sort of phonology. A more direct problem is the incompatibility between Jun's account and other phonological phenomena in Korean. I will show, on both phonetic and phonological grounds, that Jun's way of interpreting the F0 boosting cannot adequately explain the accentual H tone (H*) assignment in the realization of 'the calling contour' in Korean.

This paper does not intend to provide an articulatory explanation of the segmental effect that causes variable manifestation of the F0 perturbation in different languages. Rather, it will be focused on clarifying the phonetic or phonological status of the F0 enhancement induced by non-lenis consonants in Korean. In the remainder of this paper, I will first examine Jun's analysis of this phenomenon in detail (section 2). I will then describe the phenomena and relevant problems in the realization of the 'calling contour' in Seoul and Chonnam dialects of Korean (section 3). The results of an experiment on vocative chant² will be reported (section 4) with discussion and analysis of the phenomenon. Section 5 concludes.

²The terms 'vocative chant' and 'calling contour' are used interchangeably throughout this paper.

2 Previous Studies and Problems

2.1 Phonologization of the Laryngeal Effect: Jun (1993, 1996, 1997)

In a study of the intonational pattern in Korean, Jun (1993) argued that an Intonational Phrase in Korean consists of smaller units, viz. Accentual Phrases (APs), which are also tonally marked. Noting that the F0 of a vowel preceded by a laryngeal consonant (i.e., aspirate or tense consonant) is substantially high and stable, Jun (1993) states that the segmental effect has been phonologized in Korean. Consequently, she contends that, if an AP begins with an aspirate or tense consonant, the tonal pattern of the phrase begins with a H tone, and otherwise a L tone. Thus, she suggests that the AP in Seoul has a tonal pattern of either LHLH or HHLH and that in Chonnam either LHL or HHL, depending on the laryngeal specification of the AP-initial segment.

In her analysis, the Tone Bearing Unit (TBU) for the Seoul dialect is the syllable, while that of the Chonnam dialect is the mora. This is because Seoul is generally known to have lost, or is undergoing a complete loss of phonologically distinctive vowel length, which Chonnam still maintains. The loss of vowel length in Seoul is a characteristic of the speech of younger generation (Magen & Blumstein 1993). Ko (1999a), however, suggests that vowel length is not phonologically distinct in Chonnam, either, and that, therefore, the TBU in both dialects is the syllable.

(2) and (3) illustrate how Jun's pitch accent assignment works:

- | | | |
|---|----|---|
| <p>(2)</p> <p style="text-align: center;">L (H)L H</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[y ə ŋ s u c i ŋ]</p> <p style="text-align: center;">'receipt'</p> <p style="text-align: center;">Seoul</p> | vs | <p style="text-align: center;">L H L</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[y ə ŋ s u c i ŋ]³</p> <p style="text-align: center;">'receipt'</p> <p style="text-align: center;">Chonnam</p> |
| <p>(3)</p> <p style="text-align: center;">H (H)L H</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[p^h a r a ŋ s æ k]</p> <p style="text-align: center;">'blue color'</p> <p style="text-align: center;">Seoul</p> | vs | <p style="text-align: center;">H H L</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[p^h a a r a ŋ s æ k]</p> <p style="text-align: center;">'blue color'</p> <p style="text-align: center;">Chonnam</p> |

Jun's proposal is interesting, in that segmentally induced F0 perturbation plays an important role in the intonation pattern of Korean; but it is not

³A long vowel is represented as a geminate vowel sequence.

entirely clear whether the segmentally triggered phrase-initial H tone is phonetic, due to the undershoot of a L tone, or is phonological, i.e., part of an underlying phrase tone. In other words, although it is possible to consider the high pitch after laryngeal consonants as part of an underlying tonal pattern, it would be also possible that a phrase-initial F0 perturbation stays high due to the effect of the following H tone, in which case the boosting of F0 in vowels following non-lenis consonants would be a purely phonetic effect. One way to test the latter hypothesis would be to see how the segmental effect is realized when it is followed by a L tone instead of a H tone.

In Jun (1996), an experiment is reported which focuses on the effects of consonants on the F0 of a following vowel cross-linguistically. Its goal is explicitly to determine the status of the AP-initial H tone of Korean as either phonetic or phonological. The results of her experiment show that the F0 pattern after Korean consonants is substantially different from that of English and French. For Korean, F0 after an *aspirated* or a *tense* consonant is significantly higher (in average 50-80 Hz) than that after a lenis or a sonorant consonant, and these F0 differences persist until the end of the vowel. In English and French, however, the F0-boosting effect of consonants is not as significant: in both languages, the rise in F0 persists for only 20-40 ms after consonant onset.⁴

Jun states that if the phrase-initial raised pitch in Korean resulted from a L tone undershoot due to the following H tone, we would expect a similar pattern of F0 values both in English and French when the phrase-initial syllable is followed by a H tone. However, her experiment shows that the F0 values of English and French, even in these cases, differ only at phrase-initial position and the difference does not persist longer than 40-60 ms into the vowel. On the other hand, the phrase-initial high F0 in Korean triggered by a laryngeal consonant remains high regardless of the following tone type. Based on these results, she argues that the phrase-initial H tone in Korean is not due to phonetic undershoot but is part of the underlying representation of intonation.

However, Jun's reasoning for determining the phonological or phonetic status of the phrase-initial high F0 in Korean is questionable. It may be *phonetically* true that the effect of the Korean laryngeal consonants shows a significant difference from that of English and French. However, this in itself

⁴Compare, however, Hombert's (1978) observations:

Although the greatest difference in the F0 curves [in Figure 1] exist at vowel onset, statistical analysis (analysis of variance followed by Duncan's test) reveals that they are still significantly different 100 msec after vowel onset. (Hombert 1978: 80, emphasis added)

does not comprise a strong argument regarding the phonological or the phonetic status of the laryngeal effect in Korean. What her experiment shows is that the laryngeal effect in Korean is remarkably strong compared with the F0 perturbation phenomena found in other languages, but, strictly speaking, not anything more than that. This unusually strong segmental effect in Korean may be explained phonetically by the fact that the production of Korean aspirate and tense consonants involves different phonetic mechanisms⁵ than does the production of their nearest counterparts in English and French.

A more detailed review of Jun's argument will be given in the following section.

2.2 Problems with Jun's Analysis

Jun's analysis of the laryngeal effect in Korean as a phonological H tone seems to make sense as far as declarative utterances are concerned. For example, let us look at the following data, which are citation forms of the name 'Hyun-Cheol [hyənčəl]' in Seoul and Chonnam.

⁵The explanations proposed for such segmental effects can be summarized into two categories (Hombert 1978: 81). The first attributes the F0 perturbations to aerodynamic effects, and the second to differences in vocal cord tension.

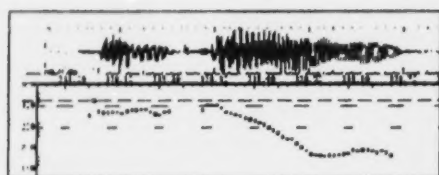
According to Hombert, researchers following the aerodynamic theory would explain the phenomenon in the following terms: after the closure of a voiced consonant, voicing continues, but since the oral pressure increases (because of the closure), the pressure drop decreases, leading to a lower frequency. In the case of voiceless consonants, since the rate of airflow is supposed to be high, a strong Bernoulli effect will draw the vocal folds together very rapidly; they will be pushed apart very rapidly as well because the subglottal pressure is high. Consequently, the rate of vibration of the vocal folds will be high at the onset of the vowel and will return gradually to the intrinsic value of the vowel being realized.

On the other hand, proponents of vocal fold tension theory claim that this perturbatory effect is too long to be attributed to aerodynamic factors. Halle and Stevens (1971) suggest that these intrinsic variations are the result of horizontal vocal cord tension, and they propose the features [stiff] and [slack] vocal cords to capture the relationship between low tone and voiced consonants (where the vocal cords are supposed to be slack in order to facilitate voicing) on the one hand, and high tone and voiceless consonants on the other hand.

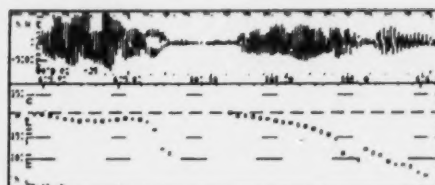
Since Korean aspirate and tense consonants, both of which show an F0 boosting effect, do not share a [voice] feature, but they are both characterized by a [stiff] vocal fold (Kim 1965), it seems that the second position is more plausible as an explanation of the Korean data. However, Hombert notes that Halle and Steven's position is not supported by experimental data by Hirose, Lisker, and Abramson (1973). Here, I will not discuss these issues further.

(4) a. Seoul

b. Chonnam

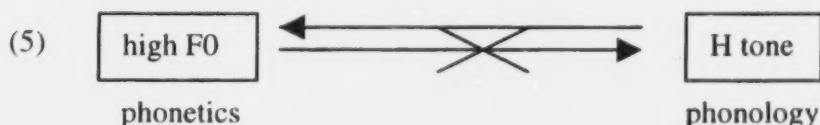


Hyun-Cheol-i
'Hyun-Cheol-citation suffix'



Hyun-Cheol-i
'Hyun-Cheol-citation suffix'

In the above pictures, it appears to be true that each phrase begins with a high pitch in both dialects. However, this in itself does not constitute a sufficient condition for its status as a phonological H tone; it is usually true that phonological H tones are realized with a high pitch,⁶ but it is not always the case that a high pitch is a phonological H tone. This assumption can be schematized as follows:



In Jun's framework, each AP assigns one of the two tonal patterns (LHLH & HHLH in Seoul, and LHL & HHL in Chonnam) out of the phrasal tonal inventory. Importantly, however, all and only instances of the initial H tone in both Seoul and Chonnam occur if and only if the initial consonant is laryngeal. Therefore, there is no independent evidence in the phrasal tonology of Korean that there is an inventory with an initial H tone apart from the cases of the laryngeal-initial AP. To argue for a phonological inventory of tonal patterns such as HHLH for Seoul and HHL for Chonnam, one would want examples of such tonal pattern independent of the segmental effect. If we could find a tonal pattern of an AP with no phrase-initial laryngeal consonant realized similarly to such examples, then we could argue more convincingly for a 'phonologization' of the segmental effect.

Another problem with treating the laryngeal effect as a phonological rule arises from the unique property of the phoneme /s/ in Korean. Unlike other obstruents, this fricative does not have a three-way distinction, but only a two-way one between lenis (/s/) and fortis (/s'/).

⁶Downdrift or other phonetic renderings of H tone are not considered.

In the following, I will show properties of /s/ which show a lenis-like behavior with regard to a phonological rule, but an 'aspirated'-like patterning regarding a phonetic phenomena.

Although /s/ phonetically involves a strong aspiration in production, thus patterning with other aspirate consonants in terms of F0 boosting, phonologically it is classified as one of the series of lenis consonants. Evidence can be found from the morphophonology of compounding, where /s/ patterns with lenis instead of aspirated consonants. The following data illustrate:

(6) Morphological gemination in compounding

- | | | | |
|---|---|---|-------------------------------------|
| a. /i + mom/ | → | [immom] | 'tooth + body' → 'gum' |
| b. /pom + palam/ | → | [pomppalam] | 'spring + wind' → 'warm wind' |
| c. /mal + sori/ | → | [malssori] | 'words + sound' → 'speech' |
| d. /p ^h ul + p ^h ili/ | → | [p ^h ulp ^h ili] | 'grass + whistle' → 'grass whistle' |
| | | (*[p ^h ulp ^h p ^h ili]) | |

In co-compounding, the second constituent of a compound undergoes gemination⁷ in Korean if it starts with a sonorant or a lenis consonant. Thus, the sonorant in (6a) and the lenis in (6b) are geminated, but the aspirated consonant in (6d) is not. We see here that /s/ phonologically patterns with the lenis consonant, instead of the aspirated consonant.

On the other hand, there is also a strong tendency for /s/ to pattern with aspirated consonants when the phenomenon is phonetic in nature. Let's take an intervocalic voicing rule in Korean, for example. Korean lenis consonants undergo voicing when in intervocalic position (7a). However, aspirate consonants and /s/, as well as fortis consonants, do not undergo voicing in the same environment (7b-d). The following examples illustrate:

- | | | | | | |
|-----|----|----------------------|---|--|-----------------|
| (7) | a. | /aki/ | → | [agi] | 'baby' |
| | b. | /isa/ | → | [isa] *[iza] | 'moving' |
| | c. | /kit ^h a/ | → | [kit ^h a] *[kid ^h a] | 'etc.' |
| | d. | /op'a/ | → | [op'a] *[ob'a] | 'elder brother' |

Silva (1992) has shown that this intervocalic voicing rule in Korean is phonetic in nature. The following example illustrates that the lenis stop voicing is sensitive to the phrasal domain:

⁷Or tensification in the case of obstruents, depending on one's view. See footnote 1. Regardless, the point holds that /s/ patterns with other lenis consonants, i.e., it becomes phonetically fortis whether via gemination or tensification.

- (8) ϕ [ω [pata] ω [palapwasse]] $\rightarrow$ [pata halabwasse]
 sea looked at
 'looked at the sea'

He demonstrates that the voicing of lenis consonants in Korean shows a different degree of voicing depending on its position in the phrase. When located within a prosodic word (ω), it undergoes a complete voicing; but when it occurs between two prosodic words, it is only partially voiced. The following table illustrates:

- (9) Positional effect on the lenis stop voicing in Korean (Silva 1992: 166)

	ϕ -Edge	ω -Edge	ω -Internal
Vocing during closure	10 ms	17 ms	33 ms
% of closure that is voiced	23%	36%	77%
Post-release VOT	60 ms	22 ms	3 ms

If the 'laryngeal effect' were truly a phonologized phenomenon, as Jun argues, we would expect /s/ to pattern with the lenis series in terms of laryngeal effect. However, if it were phonetic, it would not be surprising that /s/ once again patterns with aspirate consonants instead of the lenis. In fact, /s/ is one of the most common segments that show such a segmental effect on the F0 boosting, along with other aspirated consonants. Thus, its patterning with aspirated consonants instead of lenis supports the argument that the segmental effect is phonetic.

I contend that a criterion for determining the phonological or phonetic status of a certain phenomenon should be found where the question of categorization is more clearly involved. The phenomenon of calling contour in Seoul and Chonnam dialects of Korean serves as a good test case for this purpose. A detailed discussion of this will follow in the next section.

3 Calling Contour

In the present section, the phenomenon of calling contour is examined to clarify the nature of the 'laryngeal effect' in Korean. It is known that each language has one or more fixed tunes used for calling contours (Lieberman 1975). For example, in English and German, the calling contour is made of a H tone followed by a M tone.⁸ The H tone must be associated with the nu-

⁸Or a downstepped H tone, depending on the interpretation. It is not crucial for the present discussion.

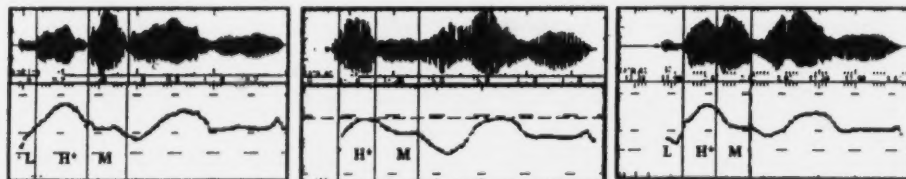
cleus or the most prominent lexically stressed syllable, thus identified as an accentual tone, H* (Ladd 1997). To my knowledge, no research on the realization of calling contour in pitch accent languages like Japanese has been reported. According to some Japanese informants⁹ I have consulted, however, the H* aligns with the H pitch accent in the Tokyo, Kansai, and Osaka dialects of Japanese.

In English, the canonical tonal pattern for calling contour is known as LH*M, where only the H* and M tones are obligatory. Thus, in names like *Amanda*, where the stress falls on the second syllable, the H* is realized on the second syllable, followed by a M tone on the third. Since there is a place to dock the L tone, namely the initial syllable, all three tones are realized. In names like *Johnny*, however, the L tone is not realized since the H* is aligned with the stressed initial syllable, and there is no place for it to dock on. On the other hand, in names like *Suzanne*, although it is also a two-syllable name like *Johnny*, all three tones of LH*M are realized. This is achieved by lengthening the stressed second syllable to accommodate both the H* and M tones. The following pictures illustrate:

(10) a. Amanda

b. Johnny

c. Suzanne



No previous phonetic or phonological research has paid attention to the realization of calling contours in Korean. If the prosodic system of Korean were a lexical stress system similar to English, we would expect the same sort of tonal patterns as English with regard to the alignment of the H* assignment; I will actually argue this for Chonnam in the next section. On the other hand, the system were a phrasal pitch accent one, as Jun has argued for Seoul and Chonnam dialects of Korean, we would expect that the H* aligns with a H tone as in Japanese case, since the syllable/mora with a H tone would be the most prominent syllable/mora in the phrase.

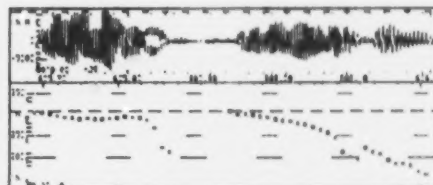
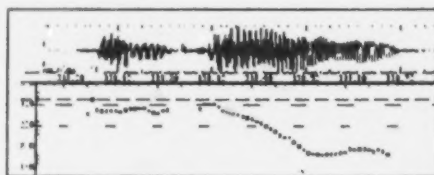
Thus, if the AP-initial H tone in Seoul or Chonnam were truly phonological as Jun argues, we would expect that the accentual H tone would align with the AP-initial H tone. If for some reason the AP-initial H

⁹Thanks are due to K. Maeda, K. Nishiyaki, and S. Haraguchi for providing me with their native speakers' intuition on this matter. It has not yet been verified by acoustic analyses.

in both Seoul and Chonnam. The pitch contour for these names in a citation form is repeated here:

(12) a. Seoul

b. Chonnam



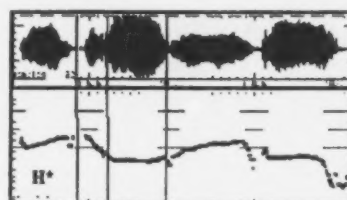
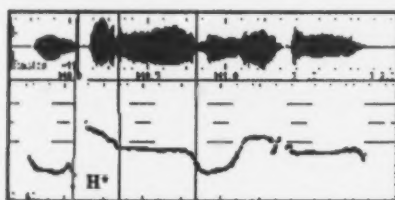
Hyun-Cheol-i
'Hyun-Cheol-citation suffix'

Hyun-Cheol-i
'Hyun-Cheol-citation suffix'

Now, compare the calling contour of the same name in Seoul and Chonnam below:

(13) a. Seoul

b. Chonnam



Hyun-Cheol-a nol-ca
'Hyun-Cheol, let's play!'

Hyun-Cheol-a nol-ca
'Hyun-Cheol, let's play!'

Contrary to our expectation, we see that the location of H* tone is different in the two dialects although they had a similar pitch contour in declaratives.

One might wonder then whether the phonologization of the laryngeal effect is valid only in Chonnam in calling contour. However, there are counterexamples to such a speculation. That is, names such as *Sang-Won*, although it begins with /s/, does not begin with an initial H*, as in the following example shows:

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(14) Pitch track of 'Sang-Won-a (nol-ca)'



In the following section, I will present the results of an experiment which examined acoustic aspects of the calling contours of Korean. It will be shown that the F0 of the initial syllable is correlated with the existence of a laryngeal consonant, but not the F0 of the non-initial syllable. It will be also shown that there is a correlation between the H tone and vowel length in the vocative chant of Korean, but that the high pitch caused by the laryngeal consonant does not correlate with vowel length.

4 Calling Contour Experiment

4.1 Method

An experiment was conducted on the performance of children's vocative chant in Seoul and Chonnam dialects in order to test the assumptions made in the previous section regarding the alignment of the accentual H tone in vocative chants. The basic function of the vocative chant used in this experiment is children calling a friend to come out and play.

Four speakers stratified by dialect and sex were solicited to read and then sing the vocative chant for 60 different names, each twice in random order. Korean names are mostly composed of two syllables, where each syllable corresponds to a sino-Korean morpheme. The frame phrases used are the following:

- (15) Frames used for declarative and vocative
- | | |
|-----------------------------------|--|
| a. Name-(i) | 'name-citation suffix' |
| b. Name-(y)a ¹⁰ nol-ca | 'name-vocative suffix play-committative' |
| | = 'Name, let's play' |

All names used in the experiment were composed of two syllables, most of which were followed by a citation or a vocative suffix.

The data were digitized at the frequency of 16,000 Hz, and acoustic analyses were conducted using a speech analysis program. The F0 and the

¹⁰'y' is inserted to avoid hiatus when the name ends in a vowel.

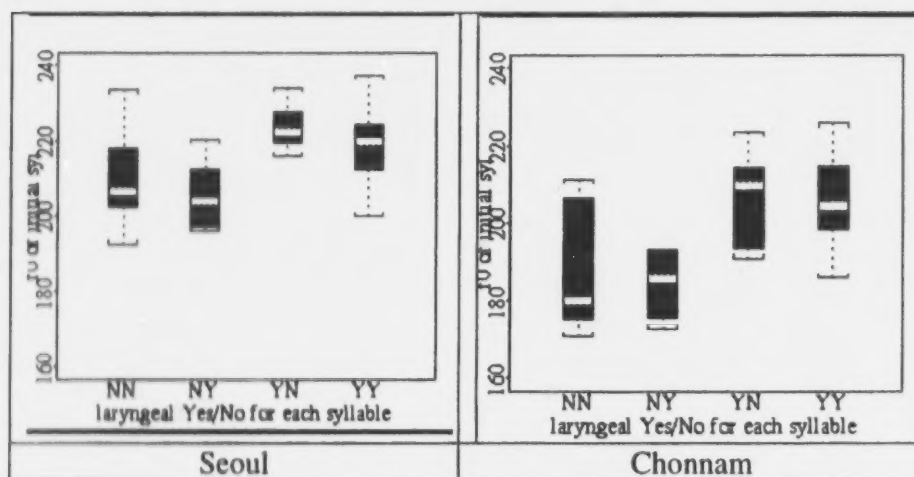
length of each syllable of the names were measured in relation to the variables (1) underlying and surface tonal pattern, (2) existence of a laryngeal onset consonant, and (3) the location of the syllable in the phrase.

4.2 Results and Discussions of the Calling Contour Experiment

4.2.1 Segmental Effect

In names beginning with a laryngeal onset consonant such as *Hyun-Cheol* and *Sang-Won*, it was found that the F0 of the initial syllable is consistently higher than in a name lacking a word-initial laryngeal onset, confirming the laryngeal effect at the phonetic level at least. The following illustrate:

(16) Laryngeal Effect in the Initial Syllable in Seoul and Chonnam



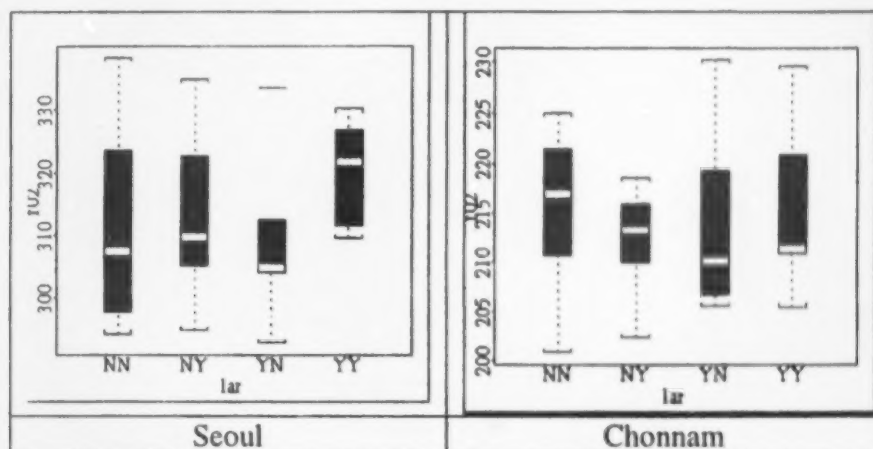
In the above box plot, the Y axis represents the F0 value of the initial syllable for each name of four different types. On the X axis, the data are labeled Y and N for each of the two syllables, where Y indicates the existence of the laryngeal onset and N the lack of one. Thus, a name such as *Sang-Won* is labeled as YN where as *Jin-Hyun* is labeled as NY.

As illustrated, the ones with laryngeal onsets show a consistently higher F0 than the nonlaryngeal onset.

However, such an effect in the non-initial position appears to be absent. The following illustrate:

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(17) Laryngeal effect in the Non-initial Syllable in Seoul and Chonnam



Here the Y axis represents the F0 values of the second syllable in each name. The interpretation of the X axis works the same way as in the graphs in (11).

We observe that the F0 value of the syllables with a laryngeal onset consonant is not necessarily higher than that of the initial syllable when the target syllable is in a non-initial position. I found the same result for cases where the target syllable is located in a third syllable in words such as *kik-wancha-ka*, 'head-car of a train-NOM'.

The question is why the high F0 in the beginning of an AP changes to a L tone in calling contour in some names but not in others in Chonnam. For example, both the names *Sang-Won* and *Hyun-Cheol* begin with a high pitch in a declarative because of the AP-initial consonant /s/ and /h/, but *Sang-Won* is realized with an initial L tone in calling contour while *Hyun-Cheol* is realized with a H tone. If the phrase-initial H in the declarative were truly a phonological H tone as Jun argues, the non-homogeneous behavior of names beginning with a laryngeal consonant in Chonnam could not be explained.

The tonal patterns of various names in calling contour will be discussed in detail in the following section.

4.2.2 Tonal Patterns and the Tone Bearing Unit of Calling Contour

The results of the experiment show that the canonical calling contour pattern of Korean is also a sequence of a H* tone and a M tone, similar to the LH*M of English. In Seoul, the location of the H* tone is always on the second syllable. In Chonnam, however, its location varies between the initial and the second syllable. Therefore, the initial L tone is realized only when the H* is

on the second syllable in Chonnam. The M tone is always realized on the vocative suffix '-(y)a' in both dialects.

The following illustrates some of the tonal patterns of various names in calling contour:

- (18) Tonal patterns of various names in the calling contour in Seoul and Chonnam

Names	Seoul	Chonnam
a. Eon-Suk, Myung-Joon, Eun-Ah (initial N)	H* on the second σ (LH*M) ¹¹	H* on the second σ (LH*M)
b. Hyun-Cheol, Seon-Suk, Ho-Jun (initial Y)	H* on the second σ (LH*M)	H* on the initial σ (H*M)
c. Young-Sun, Jae-Hun, Pyung-Chul (initial N)	H* on the second σ (LH*M)	H* on the initial σ (H*M)
d. Sang-Won, P ^h yung-Geun, Hi-Myung (initial Y)	H* on the second σ (LH*M)	H* on the second σ (LH*M)

As far as the data in (18a) and (18b) are concerned, the 'phonologized segmental effect' theory seems to be applicable to the Chonnam tonal pattern at least: names in (18a) with no laryngeal onset begin with a L tone, but those in (18b) with a laryngeal AP-initial consonant begin with a H tone. However, the data in (18c) and (18d) provide counterexamples and eliminate the possibility of explaining the tonal pattern of calling contour by segmental effect, for the names in (18c) all begin with a H* tone in the absence of a laryngeal onset, while those in (18d) start with a L tone despite the presence of an AP-initial laryngeal consonant.

Interestingly, it appears to be more reasonable to regard the syllable as the TBU in both dialects. If we follow Jun's analysis and consider the mora as the TBU of the Chonnam dialect, it is a puzzle why *Hyu:n¹²-Cheol* (HH.L) and *Sang-Won* (H.H) in declarative, according to Jun, are realized differently in calling contour as *Hyu:n-Cheol* (H* on the initial σ) and *Sang-Won* (H* on the second σ), respectively.

¹¹The tonal pattern in parenthesis reflects the M tone that is obligatorily realized on the vocative suffix, although it was not spelled-out in the table for simplicity of representation.

¹²Jun argues that vowel length is distinctive in Chonnam, and assigns two moras for a long vowel. Although later I argue the vowel length difference as an attribute of stress, thus not phonological, I marked the initial vowel as long here to show how her analysis would work in such cases.

(19) Jun's analysis of Chonnam AP tonal pattern vs. their calling contour

a. Declarative (Jun):	Hyun-Cheol-a	Sang-Won-a
TBU: μ	[h y ə ə n ɕ ə l a]	[s a ŋ w ə n a]
	 HH L L	 H L L
b. Calling contour:	Hyun-Cheol-a	Sang-Won-a
TBU: σ	 H* M	 L H* M
		

The data in (18) and (19) above lead to the conclusion that the phrase-initial H tone as a result of segmental F0 perturbation is not a phonological H tone, but is a phonetic effect.

Now the most promising solution to explain the alignment of the H* tone in the calling contour of Chonnam seems to be to bring in the notion of metrical saliency. If we assume that Chonnam is a stress language in the sense of Beckman (1986)¹³, and the stress is on the initial syllable in *Hyun-Cheol* but the second in *Sang-Won*, the assignment of the H tone in the calling contour can be explained.

The following illustrates the proposed analysis of the assignment of tones in the calling contour in Seoul and Chonnam:

(20) Tonal assignment in the calling contour of Seoul and Chonnam

a. Seoul: H* on the second syllable, M on the vocative suffix

Eon-Suk-a	Hyun-Cheol-a	Young-Sun-a	Sang-Won-a
L H* M	L H* M	L H* M	L H* M

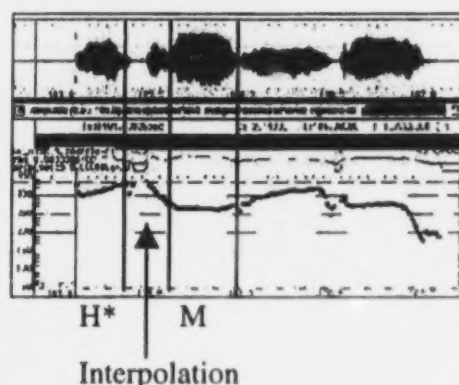
¹³According to Beckman (1986), lexical accent languages differ from pitch accent languages in that the former uses to a greater extent material other than pitch. For convenience, I adopt her definition in this paper to characterize languages that have richer phonetic properties for prominence than others. For a more elaborated phonological approach to the accent/stress/pitch accent to the prominence system of Chonnam and Seoul, see Ko (1999b).

- b. Chonnam: H* on the stressed syllable, M on the vocative suffix

Eon-Suk-a	Hyun-Cheol-a	YOUNG-Sun-a	Sang-Won-a
L H* M	H*	M H*	M L H* M

Notice that in Chonnam, names such as *Hyun-Cheol* and *Young-Sun* are realized with only the obligatory tones, i.e., H* and M, and their second syllable is unspecified for any tonal realization. A default assumption would be that its pitch is realized as an interpolation of the surrounding tones, which is borne out as the following picture illustrates:

- (21) a. Hyun-Cheol-a (nol-ca)

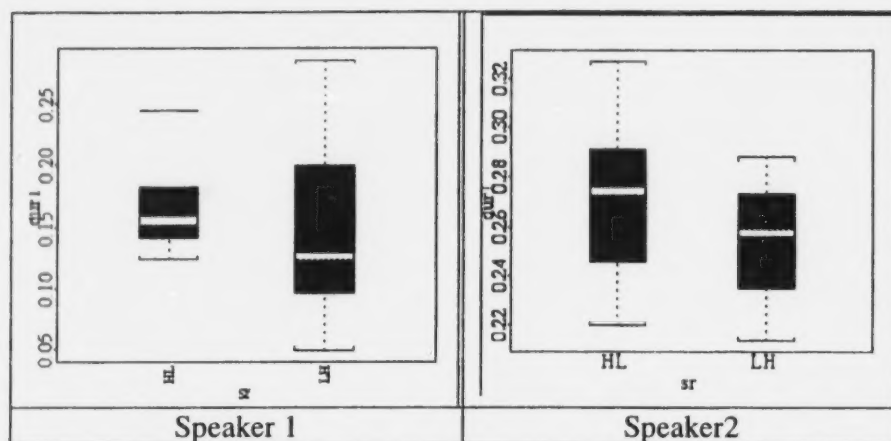


Now, since I have explained the H* alignment of Chonnam based on a lexical stress system like English, it is necessary to show grounds for arguing for a stress system in Chonnam. As mentioned in footnote 13, Beckman (1986) classifies stress-accent languages differently from pitch accent languages in that the former having richer acoustic properties of prominence such as duration, pitch and amplitude than the latter. In the following section, I will show how high pitch as a result of segmental effect differs from a true H* tone in terms of the correlation between pitch and vowel length.

4.2.3 Correlation between a H* Tone and Vowel Length in Chonnam

In Chonnam, there is additional convincing evidence in support of the claim that the H tone associated with the accentual H tone is different from the high pitch caused by the laryngeal effect: namely, the duration of the syllable associated with the H* tone is greater than that of the L tone, whereas the duration of a syllable associated with a laryngeal onset consonant appears to be arbitrary, as illustrated in (22).

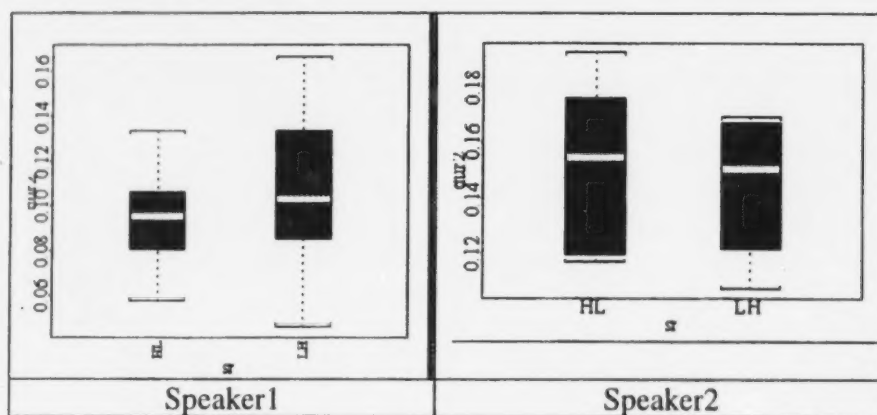
- (22) Correlation between the surface H tone and the duration in the initial syllable in Chonnam



In the above, the Y axis represents the duration of the syllable, and each bar is labeled on the X axis with the tonal shape of the corresponding names. These graphs show that there is a correlation between the tone and the duration of the syllable in Chonnam: i.e., syllables with a H tone have longer duration than those with a L tone. Such a tendency was found in both speakers of Chonnam. Especially for speaker 2, the measurements were done only on the vowels of the same quality to control the inherent vowel length difference among vowels. However, the results were consistent.

Also note, however, that the vowel lengthening is not as obvious in the second syllable, as shown in (23). Here, the Y axis represents the duration

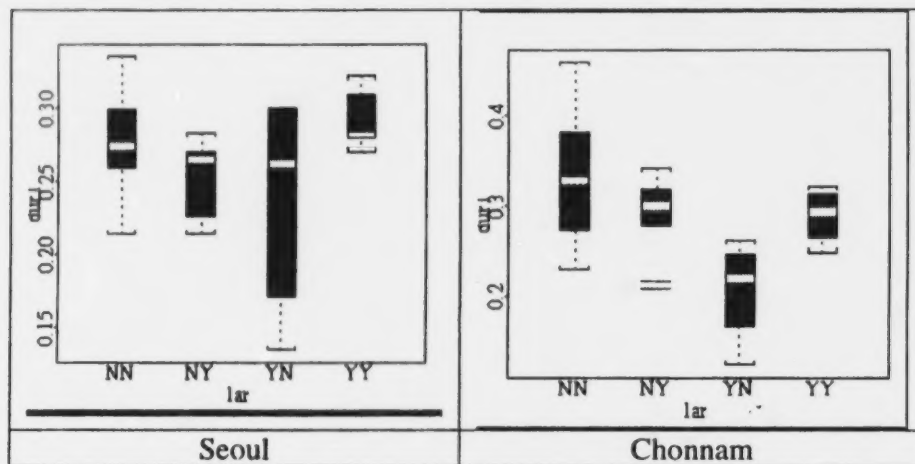
- (23) Correlation between a surface H tone and duration in the non-initial syllable in Chonnam



of the second syllable in the two types of tonal patterns. We can observe that the correlation between the tonal type of the second syllable and the duration is not strong in either speaker.

Now, the correlation between the laryngeal effect and the duration seems dubious. The following graph illustrates:

(24) Laryngeal effect and the duration of the syllable



The results of the experiment examined in this section illustrate the following two points: First, the nature of the high pitch caused by the H* tone is different from the high pitch caused by the laryngeal effect. Second, and more interestingly, the high pitch as a reflect of the H* tone in Chonnam is a manifestation of underlying stress, whose acoustic manifestation appears as pitch and duration.

5 Conclusion

In this paper, I have discussed the phonological or phonetic status of the segmental effect associated with laryngeal consonants in Korean. Contrary to the arguments made by Jun (1993, 1996, 1997), I have argued that the effect is still phonetic, although stronger than in other languages. Evidence was drawn from the assignment of the H* tone in calling contour of Seoul and Chonnam dialects of Korean. I have also shown that the realization of tonal pattern in calling contour has a close relationship with the phonological prosodic prominence system of a language.

This paper examines evidence from Sino-Korean morphemes only, mostly personal names. To give a complete picture of the prosodic system of

Korean, much more investigation, including that of native Korean vocabulary, is necessary.

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Multidimensional Exploration of Online Linguistic Field Data*

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1 Abstract

Advances in storage technology make it possible to house virtually unlimited quantities of recorded speech data online. Advances in character-encoding technology make it possible to create platform-independent transcriptions. Advances in web technology make it possible to publish this data for essentially no marginal cost. These developments have profound consequences for the accessibility, quality and quantity of linguistic field data. Recordings become accessible. Transcriptions become verifiable. Large corpora become manageable. In order to illustrate the potential for this mode of operation in field linguistics, I describe a piece of online fieldwork involving a tone language of Cameroon. A complex verb paradigm for Bamileke Dschang has been collected and transcribed, and audio and laryngograph recordings have been digitised and segmented. A central insight of Hyman's analysis concerning the domain of tone rules has been applied to the new data. A program for multidimensional exploration of the data has been developed, and can be accessed through a web version of this paper. The web page also contains digitised speech recordings of all the data items presented here.

*I am grateful to Will Leben, Mark Liberman, and two anonymous reviewers for their comments on an earlier version of this paper; I assume full responsibility for any oversights and errors it may contain. Nancy Haynes and Gretchen Harro, SIL linguists working in Bafou since 1983, unwittingly stimulated this work in their 54-page, musically transcribed verb paradigm (Harro and Haynes 1988). They also helped identify good informants, permitted me to use their village home on several occasions, and injected an uplifting mixture of sage advice and good humour. Special thanks go to Pierre Ngogeo, a retired teacher of Bafou, whose knowledge of Dschang grammar and whose ability to produce all manner of verb forms have been a major asset. This research was funded by a grant from the UK Economic and Social Research Council to Edinburgh University; it was carried out under the auspices of SIL Cameroon; and it was covered by research permits with the Ministry of Scientific and Technical Research of the Cameroon government. In return for the linguistic capital made available in the online version of this paper, this project has financed the publication of a low cost paperback dictionary (Bird and Tadadjeu 1997) and new proposals for improved tone orthographies (Bird 1999d,e). Earlier versions of this paper appeared as (Bird 1999b) and as (Bird 1999c).

These three lines of inquiry—primary description, theoretical analysis, and tool development—are synthesised, resulting in a new methodology for the investigation of linguistic field data.

2 Fieldwork as a Computational Problem

Linguistic fieldwork deals with essentially three kinds of data: lexicons, paradigms and texts. A lexicon is a database of words, minimally containing part of speech information and glosses. A paradigm (broadly construed) is any kind of rational tabulation of words or phrases to illustrate contrasts and systematic variation. Just about every data display in the *Handbook of Phonological Theory* (Goldsmith 1995) counts as a paradigm under this definition. A text is essentially any larger unit such as a narrative or a conversation. In addition to these three kinds of data, linguistic fieldwork deals with three main kinds of meta-data: field notes, descriptive reports and analytical papers.

These various kinds of data and meta-data enter into a complex web of relations. For example, the discovery of a new word in a text may require an update to the lexicon and the construction of a new paradigm (e.g., to correctly classify the word). Such updates may occasion the creation of some field notes, the extension of a descriptive report and possibly even the revision of the manuscript for an analytical paper. Progress on description and analysis gives fresh insights about how to organise existing data and it informs the quest for new data. Whether one is sorting data, or generating helpful tabulations, or gathering statistics, or searching for a (counter-)example, or verifying the transcriptions used in a manuscript, the principal challenge is computational.

Assuming that one could successfully address these issues, there are some obvious implications for theoretical linguistics. For example, the language index of the *Handbook of Phonological Theory* lists over 400 languages whose data informs contemporary theoretical investigations. The predominant distribution method for this data is print-based, relying on specialist journals and on descriptive works which are typically not in the form of archival publications.¹ Once the field data is available online, research papers can link directly to the recordings and transcriptions it contains. Readers can hear the examples, open a waveform viewer on the digitised speech, rerun the statistics, repeat database

¹Phonology is better off in this regard than some other linguistic domains. For example, the *Handbook of Contemporary Semantic Theory* (Lappin 1996) has no need for a language index since it only considers English, a stark illustration of the inaccessibility of field data.

queries, issue different queries to see how well the reported findings generalise, and so on. In this way, each research paper provides a new springboard back into the data. Of course, these developments afford no protection against asking the wrong questions or failing to collect the right data.

This paper applies computational methods to field phonology. Surveys of computational approaches to other areas of phonology can be found in Bird 1994b, 1995, and by visiting the homepage of the ACL Special Interest Group in Computational Phonology at [<http://www.cogsci.ed.ac.uk/sigphon>].

In the next section I introduce tone languages in general, and Bamileke Dschang in particular. In section 4 I describe the construction of tone paradigms and how they can be represented online. Section 5 is a more detailed treatment of downstep in Dschang, along with a discussion of double downstep. A web page accompanies this paper, and is designed to be browsed alongside the paper version. The page reproduces all of the numbered linguistic examples and data tabulations of this paper. Each data item is a hyperlink to a speech recording. The tabulations have hyperlinks to queries which produce similar tabulations dynamically. A form-based interface permits users to modify the queries and conduct their own exploration of the data, accessing thousands of speech clips, pitch traces and tone transcriptions. The page can be reached at [<http://www ldc.upenn.edu/sb/fieldwork/>].

3 An Empirical Challenge: Tone in Bamileke Dschang

Almost 2000 languages are spoken in sub-Saharan Africa (Grimes 1996). The Niger-Congo language family is the largest and by far the most important group as far as tone is concerned. This family stretches from Senegal in the west to Kenya in the east and down into South Africa, and includes the important Bantu language family. Comprehensive surveys of Niger-Congo are available (Welmers 1973, Bendor-Samuel 1989), and of tone in general (Fromkin 1978, Clements and Goldsmith 1984, van der Hulst and Snider 1993, Odden 1995). Phonetic investigations of African tone languages include: Connell and Ladd 1990, Inkelas and Leben 1990, Laniran 1992, Liberman et al. 1993, Herman 1996, and Snider 1998.

The vast majority of the Niger-Congo languages are *tonal*, i.e. voice pitch on an individual syllable may carry contrastive meaning, either lexical or grammatical. One such language is Dschang [tʃaŋ] (known to its speakers as [jém̀bà], lit. 'I say!'). Dschang is spoken in the Ménoua region of the Western Province of Cameroon, itself situated in the continental 'hinge'

between western and southern Africa. Dschang is classified as a Grassfields Bantu language (Watters and Leroy 1989). Grassfields languages manifest predominantly SVO word order and little morphology apart from a noun-class system which is simplified relative to the rest of the Bantu group (Hyman et al. 1970). The segmental phonology of Dschang has been described in detail by Haynes (1989) and Bird (1999a). A dictionary has been compiled (Bird and Tadadjeu 1997), and a short history of the development of the language has been written (Momo 1997). The phonetics of tone in Dschang is addressed by Bird (1994a), Bird and Stegen (1995) and Connell and Bird (1997). The second of these involved recordings of Maurice Tadadjeu, the original speaker on which all the data was based. The recordings are available on the web.

Dschang is noted for its rich system of terracing downstep (or progressive tonal lowering). Some unusual tone sequences H↓H, H↓L, L↓H and L↓L are attested (where ↓=downstep, H=high, L=low) and these enter into complex alternations. Dschang also manifests double downstep between high tones (H↓↓H). Dschang lacks so-called 'automatic downstep'—H lowering due to a preceding linked L. Some of the tonal alternations have been the subject of several published studies: Clark 1993, Hyman 1985, Hyman 1993, Hyman and Tadadjeu 1976, Pulleyblank 1986, Anderson 1980, Stewart 1981, Stewart 1993, Tadadjeu 1974. This paper presents a large body of new data, transcribed from laryngographic recordings of Dschang speakers in Cameroon. In marked contrast to the existing studies which have focussed on the associative construction, this study focuses on the verb phrase. The Dschang verb phrase is interesting for reasons other than tone (Hyman 1980), but only tone will be discussed here.

Example (1) demonstrates the use of tone to distinguish lexical meaning. All the forms are morphologically marked as nouns (viz. the class 5 *lâ-* prefix). Tadadjeu (1974:284) was the first to report this data, and the roots (i.e., the second syllables) have been tonally classified according to the scheme laid out by Hyman (1985:48).

- | | | | | |
|--------|----|----------------------|------|-------------|
| (1) a. | H | lât [˥] ɔŋ | [˥] | 'feather' |
| b. | HL | lât ^{˥˥} ɔŋ | [˥˥] | 'reading' |
| c. | LH | lât ^{˨˨} ɔŋ | [˨˨] | 'navel' |
| d. | L | lât ^{˨˨} ɔŋ | [˨˨] | 'finishing' |

Note that, following standard practice, acute accent (˥) indicates high tone and grave accent (˨) indicates low tone. These diacritics are combined to create rising (˥˥) and falling (˨˨) tone. Phrase-final low tones are falling, except when transcribed with a following degree sign. In the northern (Bafou)

dialect of Dschang (which has been the focus of most of the research on the language) a phrase-final H tone, when preceded by L, is realised as a rising tone. This accounts for the form we see in (1a). All data items in this paper are accompanied by line diagrams, i.e. 'pitch transcriptions', to avoid the ambiguities of interpretation that occur when only tone-marked segmental transcriptions are given.

Example (2) illustrates the use of tone to convey grammatical contrasts. The three examples use the same lexical items: *əfɔ̃* 'chief', *kəmtè* 'bury', *məmbh^hú* 'dogs'. The vowels in isolation are concord markers that will be discussed later. (Note that the pitch transcriptions for phrases include vertical bars; these indicate word domain boundaries, and will be explained in section 5.3.)

- (2) a. *əfɔ̃ ɔ̃ 'kəmtè 'məmbh^hú* [-|~|--|~] 'the chief buried dogs'
'(immediate past)'
b. *əfɔ̃ ɔ̃ kəmtè məmbh^hú* [-|~|---|~] 'the chief buries dogs'
'(simple present)'
c. *əfɔ̃ ɔ̃ 'kəmtè 'məmbh^hú* [-|~|~|---] 'the chief will bury dogs'
'(immediate future)'

The value of using a two-way tone contrast H/L along with what we now know as floating tones (to condition downstep) was recognised by Voorhoeve (1971) and exploited extensively by Hyman and Tadadjeu (1976) and most subsequent work on the language group.

The mere existence of lexical and grammatical tone might not be particularly interesting if it were not for the fact that Dschang manifests some particularly intriguing tonal alternations. Example (3) illustrates the alternations that *məmbh^hú* 'dogs' enters into.²

- (3) a. L↓H *əfɔ̃ ɔ̃ məmbh^hú* [-|---|~] 'chief of dogs'
b. ↓HH *əfɔ̃ ɔ̃ 'kəmtè 'məmbh^hú* [-|~|~|---] 'the chief will bury dogs'
c. H↓H *əfɔ̃ 'ɔ̃ kápté məmbh^hú* [-|~|~|---] 'the chief will cover dogs'
d. H↓L *əfɔ̃ 'ɔ̃ kápté məmbh^hú* [-|~|~|~|] 'will the chief cover dogs?'

²Needless to say, this state of affairs poses some interesting challenges for orthography. A reading experiment has demonstrated that a phonemic orthography for the tone system is unworkable (Bird 1999e).

4 Constructing Tone Paradigms and Putting Them Online

4.1 Selection of Nouns

We have already seen the four possible tone melodies of nouns in (1). Linking a noun with following material requires a vocalic concord marker (CM). The tone borne by this marker is L for nouns in classes 1 and 9, and H otherwise, i.e. for classes 2–8 (Hyman 1985: 49). This two-way choice leads to eight possibilities for the subject noun, as listed in (4). The subject nouns were required to be human so they could legitimately function as agents in the sentence constructions. Minimal pairs were avoided since it was found that these are too easily confused in elicitation sessions involving complex paradigms.

- (4) a. H+L ñdǝŋ [-'] 'lazy man'
 b. HL+L ñmb'úŋ [-] 'poor man'
 c. LH+L fǝk' [-] 'cowife'
 d. L+L əfǝ [-\] 'chief'
 e. H+H mǝlǝŋ [-'] 'lazy men'
 f. HL+H mǝp'úŋ [-] 'poor men'
 g. LH+H mǝfǝk' [--] 'cowives'
 h. L+H mǝfǝ [-\] 'chiefs'

For the object nouns I have retained Hyman's set. This controls for the lexical tone of the noun, and the presence or absence of a low tone prefix. (Note that the tone of *sǝŋ* and *'mǝ* are indistinguishable in isolation.)

- (5) a. L+H mǝtsǝŋ [-'] 'thieves'
 b. L+HL mǝmbh'ú [-] 'dogs'
 c. L+LH mǝŋkùǝ? [--] 'roosters'
 d. L+L mǝnzwi [-\] 'leopards'
 e. H sǝŋ [-] 'bird'
 f. HL 'mǝ [-] 'child'
 g. LH kǝŋ' [-] 'squirrel'
 h. L nǝ [-\] 'animal'

For the associative (or genitive) construction, one juxtaposes these two sets of nouns in all possible ways to get 64 combinations: noun₁-CM-noun₂. However, here we shall employ the nouns in the construction of verb paradigms.

4.2 Verb Paradigms

In constructing verb paradigms some additional steps were necessary. Unlike nouns, verbs exhibit a two-way tone contrast between H and L. Verbs may be mono- or bisyllabic, but the second syllable (a CV verbal extension) is never contrastive for tone. Simplifying somewhat, in forming an SVO phrase two concord markers and one or more tense-aspect markers (TAM) are required: subject-CM₁-TAM-verb-CM₂-object. This looks rather like two copies of the associative construction, and yet in this construction we can observe tone sequences like H↓L and H↓↓H which are not attested in the associative construction. The same can be said for certain longer sequences. For example, the L↓HL sequence does not appear in the associative construction and Hyman (1985: 62) has a rule converting it to L↓LL. However, in the verb paradigm we find L↓HL on low toned verbs in the immediate past conditional when followed by a prefixed noun. For example: *əfə ə kəmt'ɛ məmbh'ú* [-|-|-|-] 'if the chief just buried dogs'. These new possibilities provide a useful testbed for evaluating existing analyses of the tone system.

The tone of CM₁ depends on the class of the subject noun, as before. The tense-aspect marker contributes tonal material, and sometimes segmental material as well. The tone contributed by CM₂ depends on the tense-aspect. Table 1 illustrates the situation, fixing the subject and object nouns, inserting two verbs, and running through nine traditionally recognised 'tenses'.³

Note that the transcriptions reported in Table 1 are being continually updated as part of the online fieldwork. Please refer to the online transcriptions rather than this snapshot for updates. Note also that there is a degree of arbitrariness about ↓↓ placement in Table 1. If we have a sequence [-|-] and there is independent evidence that the initial and final pitches both correspond to H, then we could have H↓↓HH or HL↓↓H, an indeterminacy which can only be resolved by analysis. Bird (1994a) documents other transcriptional indeterminacies in the context of the parametric system of tone interpretation proposed by Liberman et al. (1993). The pitch transcriptions are immune to this indeterminacy problem.

Fortunately, it is not necessary to repeat the above process with each of the 64 noun pairs. The addition of the verb permits a simplification of the tonal paradigm. We can fix the object noun and elicit all combinations of the eight

³The tense labels, following (Hyman 1980), are P5=remote past, P3=yesterday past, P2=today past, P1=immediate past, PR=present, PP=present progressive, F1=immediate future, F4=after tomorrow future, F5=remote future. The following pairs of tenses appear to be tonally identical and so have been represented by one member: P4=P3, F2=F5, F3=F4.

	High tone verb: <i>kapte cover</i>	Low tone verb: <i>kəmtə bury</i>
P5	əfɔ̃ ɔ̃ lələ? ɲk ¹ ápté mós ¹ ɔ̃ɲ [- - - - - - -]	əfɔ̃ ɔ̃ lələ? ɲkəmtè ¹ mós ¹ ɔ̃ɲ [- - - - - - -]
P3	əfɔ̃ ɔ̃ kè kápté mós ¹ ɔ̃ɲ [- - - - - -]	əfɔ̃ ɔ̃ kè ¹ kəmté mós ¹ ɔ̃ɲ [- - - - - -]
P2	əfɔ̃ ɔ̃ ɲk ¹ ápté mós ¹ ɔ̃ɲ [- - - - - -]	əfɔ̃ ɔ̃ ¹ ɲkəmté mós ¹ ɔ̃ɲ [- - - - - -]
P1	əfɔ̃ ɔ̃ ¹ kápté mós ¹ ɔ̃ɲ [- - - - -]	əfɔ̃ ɔ̃ ¹ kəmtè ¹ mós ¹ ɔ̃ɲ [- - - - -]
PR	əfɔ̃ ɔ̃ ¹ kəptè mós ¹ ɔ̃ɲ [- - - -]	əfɔ̃ ɔ̃ kəmtè mós ¹ ɔ̃ɲ [- - - -]
PP	əfɔ̃ ɔ̃ ¹ sé ɲkápté mós ¹ ɔ̃ɲ [- - - - - -]	əfɔ̃ ɔ̃ ¹ sé ɲk ¹ əmté mós ¹ ɔ̃ɲ [- - - - - -]
F1	əfɔ̃ ¹ ɔ̃ kápté mós ¹ ɔ̃ɲ [- - - -]	əfɔ̃ ɔ̃ ¹ kəmtè ¹ mós ¹ ɔ̃ɲ [- - - -]
F4	əfɔ̃ ɔ̃ ¹ lù ¹ ú kápté mós ¹ ɔ̃ɲ [- - - - -]	əfɔ̃ ɔ̃ ¹ lù ¹ ú kəmtè ¹ mós ¹ ɔ̃ɲ [- - - - -]
F5	əfɔ̃ ¹ ɔ̃ fú ¹ kápté mós ¹ ɔ̃ɲ [- - - -]	əfɔ̃ ¹ ɔ̃ fú kəmtè ¹ mós ¹ ɔ̃ɲ [- - - -]

Table 1: A tense-based slice through the paradigm, for indicative mood

subject nouns and the two verbs (i.e., 16 sentences), then fix the subject noun and elicit all combinations of the two verbs with the eight object nouns (i.e., another 16 sentences). Discarding the two sentences that are duplicated in this process, we have a total of 30 sentences to elicit for each tense-aspect. Table 2 illustrates part of this process for the H verb.⁴

Varying object nouns			Varying subject nouns		
L	əfɔ̃ ¹ ɔ̃ kápté mánzwì ¹ ì	[- - - - -]	əfɔ̃ ¹ ɔ̃ kápté mós ¹ ɔ̃ɲ ɲ		[- - - - -]
LH	əfɔ̃ ¹ ɔ̃ kápté mánk ¹ à? ¹ ì	[- - - - -]	fòk ¹ ó kápté mós ¹ ɔ̃ɲ ɲ		[- - - - -]
HL	əfɔ̃ ¹ ɔ̃ kápté mám ¹ bh ¹ à ¹ à	[- - - - -]	m̃b ¹ ùɲ ¹ ɔ̃ kápté mós ¹ ɔ̃ɲ ɲ		[- - - - -]
H	əfɔ̃ ¹ ɔ̃ kápté mós ¹ ɔ̃ɲ ɲ	[- - - - -]	nd ¹ ɔ̃ɲ ¹ ɔ̃ kápté mós ¹ ɔ̃ɲ ɲ		[- - - - -]
L	əfɔ̃ ¹ ɔ̃ kápté nà ¹ à	[- - - -]	məfɔ̃ ¹ ɔ̃ kápté mós ¹ ɔ̃ɲ ɲ		[- - - - -]
LH	əfɔ̃ ¹ ɔ̃ kápté kàɲ ¹ ɲ	[- - - -]	məf ¹ ók ¹ kápté mós ¹ ɔ̃ɲ ɲ		[- - - - -]
HL	əfɔ̃ ¹ ɔ̃ kápté ¹ mò ɔ̃	[- - - -]	məp ¹ úɲ ɲ ¹ kápté mós ¹ ɔ̃ɲ ɲ		[- - - - -]
H	əfɔ̃ ¹ ɔ̃ kápté sàɲ ¹ ɲ	[- - - -]	məlɔ̃ɲ ɲ ¹ kápté mós ¹ ɔ̃ɲ ɲ		[- - - - -]

Table 2: A noun-based slice through the paradigm, for F1 interrogative

These 30 items were then elicited for the nine tenses listed in Table 1, to create a paradigm of 270 items. This process was repeated for five mood/voice

⁴The *e~ɛ* alternation in the verb in the left column of Table 2 is addressed in section 5.3.

possibilities: indicative, negative, interrogative, conditional and focus, each adding interesting new tonal information to the sentences. The full dataset of 1350 items was digitally recorded for three speakers (with audio and laryngograph channels) and then uploaded and segmented to create 8100 speech clips.

4.3 Paradigm Tool

A flexible tool has been developed for navigating the data along any of its dimensions, constructing tabulations of interesting slices through the hypercube of data, viewing pitch traces, and listening to digitised speech data. The tool is written in Perl (Wall et al. 1996) and operates as a 'Common Gateway Interface' (CGI) program on the web, providing users with a familiar forms-based interface. Its design is based on *HyperLex* (Bird 1997), with influences from the SIL programs Shoebox (Buseman et al. 1996) and FindPhone (Bevan 1995) [<http://www.sil.org/computing/>].

The internal format of the data uses the SIL STANDARD FORMAT, as used, for example, by Shoebox. Table 3 contains a record from the database. Non-roman characters are encoded using capital letters, for example ɔ appears as 'O' in the database, but is correctly rendered in the web browser.

\re 0001	# record id
\va	# validation status
\sp pn	# speaker
\tn fl	# tense
\md a	# mood
\au OH1	# audio file pointer
\ts L	# tone on subject
\cl l	# noun class
\tv H	# tone on verb
\op y	# object pronoun (y/n)
\to L	# tone on object
\dt [RH]	# domain type
\tr efO kapte menzwi	# ascii transcription
\pi 3 3 1 1 1 1 35	# pitch numbers
\se e fO a kap te men zwi	# segmental tier
\as /	# associations
\t L L *H H *H L L	# tone tier
\cm	# comment

Table 3: Shoebox entry for the utterance ɛfɔ́ ɔ́ kápté mánzwi

This format is very flexible, and new fields can be added as the need arises. For example, we may want to have multiple pitch-number transcriptions, contributed by different transcribers. Different assumptions about the nature of downstep lead to different tone transcriptions (cf. Stewart 1993). We could equally represent tone sequences at varying levels of abstractness or adopt different theoretical positions (e.g., an analysis using three basic tones instead of two). One could expand the database in these ways, or construct a derived database which retains certain fields while replacing others.

The record in Table 3 also contains an ASCII version of an autosegmental diagram, with asterisks denoting grammatical tones. This format is simple to maintain in the database, and it can be used to generate more readily recognisable diagrams inside a web browser.

For run-time efficiency, the SIL Standard Format for each entry is compiled into a one-line format consisting of colon-separated fields, where many of the fields are preprocessed into HTML. As a temporary measure until Unicode [<http://www.unicode.org>] is more widely implemented and adopted, special characters are represented using dynamic fonts, and also translated into small graphics images.⁵

The web interface provides a fill-in form for querying the database. Search expressions can be applied to any of the database fields, and employ 'regular expression' syntax. A pull-down menu is used to select the field. Beside this, there is a checkbox to indicate whether the result should be tabulated according to the values found for this field. And alongside this, there is an area for the constraint to be entered; see Table 4 for examples. This triple—the field name, axis-control checkbox and constraint—queries a single field. The form has room for up to eight fields to be queried in parallel, permitting fine control of the search. Only fields which are to be used to constrain the output need to be explicitly constrained. The form also allows the user to control which field(s) should be displayed in the resulting table.

5 Downstep in Bamileke Dschang

This section presents a sketch of downstep patterning in Dschang. It is not my intention here to provide another analysis relating surface forms right back to the underlying (or proto-) forms. Rather, I wish to provide a descriptive discussion of the interesting cases which any theoretical account has to deal with, and illustrate the use of the paradigm system to generate useful tabulations.

⁵These occupy about 160 bytes each and do not represent a significant overhead for use on the web. In any case, each character only needs to be downloaded once.

Field Name	Values	Notes
Tense	p5, p3, p2, p1	past 5 ... past 1
	pr, pp	simple present, present progressive
	f1, f4, f5	future 1 ... future 5
	f.	any future tense ('.' matches any single character)
	.1	immediate past (p1) or immediate future (f1)
Mood	a, n	affirmative (=indicative), negative
	i, c, f	interrogative, conditional, focus
	[an]	any affirmative or negative form
Tone (subj)	H, HL, LH, L	the lexical tone of the subject noun (after Hyman)
	HL	HL subject nouns: m̀b ⁴ úŋ, m̀p ⁴ úŋ
Class	1, 2	the noun class of the subject noun
	2	the class 2 (i.e. plural) subject nouns (e.g. m̀l̩ŋ)
Tone (verb)	H, L	the lexical tone of the verb
	H	the H subject nouns: m̀b ⁴ úŋ, m̀p ⁴ úŋ
Obj prefix	y, n	whether the object has the m̩- prefix (yes/no)
	n	the prefixless object nouns: s̩ŋ, m̩mbh̩ ⁴ ú, k̩ŋ, n̩
Tone (obj)	H, HL, LH, L	the lexical tone of the object noun
	. *L	the tone patterns ending in L (i.e. HL, L)
Pitches	1 ... 6	the pitch transcription
	(213 324 435)	pitch sequences corresponding to L ⁴ HL

Table 4: Database field values and their use in constructing queries

Readers are encouraged to use this discussion as a starting point for their own exploration of the data, sharing intermediate results in the same manner as I have done here.

5.1 Downstep Conditioned by Low Tone

A pervasive kind of downstep in many Niger-Congo languages can be treated using the theoretical construct of 'floating low tones', symbolised here using parentheses, as (L). In this section we review two kinds of (L) tone, one which only lowers a following H tone, and one which lowers all following tones.

Example (6a) shows *m̀ts̩ŋ* 'thieves' as it appears following a low concord tone. This is the same as the isolation form of the word. We see the plural prefix *m̩-* followed by the high tone root *ts̩ŋ*, which is realised as rising tone in phrase-final position. In (6b) we see a rather different situation, where the

high concord tone is copied (or spread) onto the *mə-* prefix, and the low tone of this prefix shows up as downstep.

- (6) a. *èfɔ̀ ɔ̀ kɛ̀ mət̩sɔ̃ŋ* [-|---|'] 'chief of thieves'
 b. *àsánŋ á mət̩sɔ̃ŋ* [-|'---|'] 'tail of thieves'

This downstep only lowers high tone; the lexical contrast between H and ↓H is neutralised here. Consider example (7), which illustrates this neutralisation for *məmbh'ú* 'dogs' and *mət̩sɔ̃ŋ* 'thieves'.

- (7) a. *àsánŋ á məmbh'ú* [-|'---|'] 'tail of dogs'
 b. *àsánŋ á mət̩sɔ̃ŋ* [-|'---|'] 'tail of thieves'

Regardless of how one chooses to represent the various tones and how one provides explicit formal mechanisms for tones to influence each other, the fact remains that this type of (L) is sensitive to the identity of the following tone. Now we turn to a kind of (L) which is not sensitive in this way. In fact, it lowers *every* tone after H, regardless of its identity, as shown in Table 5 (cf. Hyman and Tadadjeu 1976).⁶ Observe that the final word of each indicative form is downstepped relative to the final word of the corresponding conditional form.

	Indicative	Conditional
L	<i>èfɔ̀ ɔ̀ kɛ̀ kápté 'nà</i> [- --- '↘]	<i>èfɔ̀ ɔ̀ kɛ̀ kápté nà</i> [- --- '↘]
LH	<i>èfɔ̀ ɔ̀ kɛ̀ kápté 'kàŋ</i> [- --- '↘]	<i>èfɔ̀ ɔ̀ kɛ̀ kápté kàŋ</i> [- --- '↘]
HL	<i>èfɔ̀ ɔ̀ kɛ̀ kápté 'mó</i> [- --- '↘]	<i>èfɔ̀ ɔ̀ kɛ̀ kápté 'mó</i> [- --- '↘]
H	<i>èfɔ̀ ɔ̀ kɛ̀ kápté 'sónŋ</i> [- --- '↘]	<i>èfɔ̀ ɔ̀ kɛ̀ kápté sóŋ</i> [- --- '↘]

Table 5: Yesterday past indicative for H verbs with prefixless object nouns

Accordingly, we have evidence for a 'weak' (L) which only downsteps H tone, and a 'strong' (L) which can downstep any tone. Now we turn to (H) and observe analogous behaviour.

⁶Note that the informant did not tonally distinguish *kàŋ* and *nà*, even though the former is supposed to be non-falling (cf. (5f)) and has been verified as such in the speech of Maurice Tadadjeu. I noted significant variation across speakers for the L/L' contrast, with a tendency for collapsing the distinction in many contexts.

5.2 Downstep Conditioned by High Tone

Consider the $\downarrow H \sim \downarrow L$ alternation in example (8). In (8a) we have the $\downarrow H$ root $^1púŋ$ while in (8b) we see the same root (with allophonic voicing) with $\downarrow L$ tone: $^1bùŋ$.

- (8) a. $məp^1úŋ \eta \ kəmtè \ mət̥sɔŋ [-\downarrow---\downarrow]$ 'poor men bury thieves'
 b. $m̥b^1ùŋ \grave{\eta} \ kəmtè \ mət̥sɔŋ [-\downarrow---\downarrow]$ 'the poor man buries thieves'

Assuming that the phonological representation of $\downarrow H$ contains a H tone (e.g., as (L)H), this H is absent from any vowel in $m̥b^1bùŋ$, though it explains the presence of the downstep. Similar examples exist in the associative construction, cf. (9), and with the possessive marker, cf. (10).

- (9) a. $ɛfɔ \grave{\eta} \ mənzwì [-\downarrow---\downarrow]$ 'chief of leopards'
 b. $ùlɔŋ \grave{\eta} \ mənzwì [-\downarrow---\downarrow]$ 'stool of leopards'
- (10) a. $nd^1ɔŋ [-\downarrow]$ 'horn'
 b. $nd^1ɔŋ \ zà [-\downarrow]$ 'my horn'

Note, however, that in all these cases, (H)L only shows up as $\downarrow L$ if there is a preceding-L tone. Although (11a) has a $\downarrow L$, the conditions are not right for $\downarrow L$ in (11b).

- (11) a. $ùlɔŋ \grave{\eta} \ mənzwì [-\downarrow---\downarrow]$ 'stool of leopards'
 b. $àsáŋ \acute{\alpha} \ mənzwì [-\downarrow---\downarrow]$ 'tail of leopards'

Now we consider a variety of (H) which downsteps the following L regardless of the preceding tone. Consider the items in Table 6. Looking across each row, observe that the only difference is the presence of a $\downarrow L$ for the H verb and just a plain L for the L verb. Evidently the lexical tone of the H verb is showing up as downstep, and this is not sensitive to prior context. A promising way to approach the problem systematically is provided by Hyman's notion of word domains (Hyman 1985).

5.3 Word Domains

Hyman (1985: 59ff) has identified the *phonological word* as the prosodic domain in which the majority of Dschang tone rules apply.⁷ According to

⁷For another example of tonal behaviour which is sensitive to prosodic constituency, see Leben and Ahoua 1997.

High tone verb: <i>kapte cover</i>		Low tone verb: <i>kəmtə bury</i>	
L	əfɪ́ ɔ́ 'kàptè mət̚sɔ́ŋ [- -- --- /]	əfɪ́ ɔ́ kəmtè mət̚sɔ́ŋ [- -- --- /]	
LH	fòk ɔ́ 'kàptè mət̚sɔ́ŋ [-- --- /]	fòk ɔ́ kəmtè mət̚sɔ́ŋ [-- --- /]	
HL	m̩b'ùŋ ɔ́ 'kàptè mət̚sɔ́ŋ [- -- --- /]	m̩b'ùŋ ɔ́ kəmtè mət̚sɔ́ŋ [- -- --- /]	
H	nd̩ɔ́ŋ ɔ́ 'kàptè mət̚sɔ́ŋ [- -- --- /]	nd̩ɔ́ŋ ɔ́ kəmtè mət̚sɔ́ŋ [- -- --- /]	
L	məfɪ́ ɔ́ 'kàptè mət̚sɔ́ŋ [- ' --- /]	məfɪ́ ɔ́ kəmtè mət̚sɔ́ŋ [- ' --- /]	
LH	məf'ók 'kàptè mət̚sɔ́ŋ [- ' --- /]	məf'ók kəmtè mət̚sɔ́ŋ [- ' --- /]	
HL	məp'úŋ ɪ́ 'kàptè mət̚sɔ́ŋ [- ' --- /]	məp'úŋ ɪ́ kəmtè mət̚sɔ́ŋ [- ' --- /]	
H	məlɔ́ŋ ɪ́ 'kàptè mət̚sɔ́ŋ [- ' --- /]	məlɔ́ŋ ɪ́ kəmtè mət̚sɔ́ŋ [- ' --- /]	

Table 6: Simple present indicative varying subject and verb

Hyman's definition, phonological words extend from the root of one word, through any suffix or concord marker, up to and including any prefix on the next word. As mentioned above, the pitch transcriptions used throughout this paper indicate phonological word boundaries using a vertical bar.

Phrase-internal phonological words appear to be minimally bimoraic. The apparent counterexample of *məf'ók* in Table 6 evidently contains a silent beat after the *k* in order to satisfy this constraint. (The reader is encouraged to verify this claim by listening to the recording.) The other apparent counterexamples are the mono-moraic auxiliaries for yesterday past (P3) and distant future (F5) in Table 1. The short duration and low intensity of these morphemes seem to place them on a par with affixes rather than full roots, and so they are not assigned their own word domains.

As independent confirmation for the existence of word domains, there is an interesting vowel alternation that may be explained with reference to a limitation on the complexity of phonological words. Consider the phrases in (12), with surface forms on the left and putative underlying forms of the main phonological word on the right. The first two lines use the bisyllabic verb root *kapte*, while the last two lines use the monosyllabic verb root *pok* plus an echo vowel whose morphological status is unclear.

- (12) a. ləkaptè mət̚sɔ́ŋ [kap te mə]pw 'to cover thieves'
 b. ləkaptè nà [kap te a]pw 'to cover the animal'
 c. ləpoko mət̚sɔ́ŋ [pok o mə]pw 'to anoint thieves'
 d. ləpoko nà [pok o a]pw 'to anoint the animal'

The data in (12) shows that the concord marker (at least, its segmental content) is only present when the object noun lacks a prefix.

5.4 Towards an Inventory of Domain Types

Table 7 contains pitch transcriptions which were selected and tabulated using the paradigm system. The left side shows the indicative mood, for H and L tone verbs respectively (see Table 1 for the segmental transcription), and the right side shows the negative mood. As before, each row represents a different 'tense'.

	<i>Indicative</i>		<i>Negative</i>	
	H verb: kapte	L verb: kəmte	H verb: kapte	L verb: kəmte
P5	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]
P3	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]
P2	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]
P1	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]
PR	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]
PP	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]
F1	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]
F4	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]
F5	[+--- ---]	[+--- ---]	[+--- ---]	[+--- ---]

Table 7: Pitch transcriptions for əfɔ ... mətsɔŋ

Although there is too much going on in this data to adequately address here, there are some interesting facts about domain types to be gleaned from it. First, consider the final domain boundary of each pitch transcription, along with the relative pitch value on either side. These two pitch values correspond to the word *mətsɔŋ*. Ignoring relative pitch height, there are only three possibilities: [-], [+], and [-]. (But recall that another possibility for *mətsɔŋ* was shown in Table 2.) The three possibilities in Table 7 are the same three that we see for *mətsɔŋ* in the associative construction (Hyman 1985:50), and are laid out in (13), where X stands for either H or L.

- (13) a. radical = X, CM = L: [-], [-]
 b. radical = L, CM = H: [+], [+], [-]
 c. radical = H, CM = H: [-], [-], [-], [-]

A tabulation of just the relevant data from Table 7 is given in Table 8. Note that the tabulation is inverted from Table 7; tense and verb tone are classified with respect to pitch information, rather than the other way around. The row labels have been grouped so that the tones on either side of the domain boundary stand in the same relationship to each other. The five non-empty cells are themselves structured according to the lexical tone of the verb. (Thus, Table 8 really has three dimensions.)

Pitch Sequence	Indicative	Negative
[-/], [-/]	H: P3, PR L: P3, PR	
[+/], [+/], [-/]	L: P5, P1, F1, F4, F5	L: P2, F1, F4, F5
[+/], [+/], [-/], [-/]	H: P5, P2, P1, PP, F1, F4, F5 L: P2, PP	H: P5, P3, P2, P1, PR, PP, F1, F4, F5 L: P5, P3, P1, PR, PP

Table 8: Tense and verb-tone classified by domain boundary type

The first row of Table 8 corresponds to (13a). The tone on the radical contributes nothing to the tonal behaviour at the domain boundary, showing up elsewhere. I posit a L tone concord marker, provided by tenses P3 and PR in the indicative. This will be classified as [RL]—a domain consisting of the radical tone plus a L grammatical tone. The second row corresponds to (13b). Observe that all the radicals are L. In order to get the desired pitch sequence at the boundary we can posit a H tone concord marker for all L tone verbs in any future tense, and for L tone verbs in P5 indicative, P1 indicative and P2 negative. These will be classified as [RH]. The most interesting case is the third row, which we would like to put into correspondence with (13c). The H tone verbs fit the pattern, so long as we stipulate a H tone concord marker as well, and so these can also be classified as [RH]. However, the L tone verbs break the pattern. Evidently the lexical contrast is not expressed at this position. Nevertheless, we can go ahead and attribute a grammatically conditioned H tone to the L radical in these cases, observing that this radical never shows up overtly, but only as downstep at the preceding domain boundary. This category will be labelled [$\downarrow$ HH].

Since each possibility for *mətsəŋ* represents a set of patterns for the other object nouns, the above procedure can be generalised after the necessary checks have been carried out; it is not necessary to start afresh with each new object noun. In this way, with the help of various stipulations concerning the

grammatical tone contributed by the tense and mood, we can see how any analysis of the associative construction can be generalised to cover this position. The next exercise is to work leftwards through each item in Table 7, attempting to classify each domain and each domain boundary in order to determine the tonal contribution of the grammatical construction and to determine the fate of the lexical tones. Those who attempt this exercise—and it is not recommended for the faint-hearted—will soon discover that the word domains familiar from the associative construction do not cover all the necessary cases. Attributing tone behaviour at boundaries to the preceding or following domain is especially tricky. I believe it is helpful to consider the possibility that domains condition downstep *to their right*, taking no account of the identity of the tones to be found there (since those tones cannot be seen). This requires the creation of domain types like $[RH\downarrow]$. We can now distinguish $\dots H][\downarrow\dots$ 'weak (L)' from $\dots H\downarrow][\dots$ 'strong (L)' and $\dots\downarrow][L\dots$ 'weak (H)' from $\dots][\downarrow L\dots$ 'strong (H)'. Furthermore, the occurrence of $H\downarrow\downarrow H$, only possible at domain boundaries, may then be represented as the sequence $\dots H\downarrow][\downarrow H\dots$

Whatever the details may be, we proceed by constructing new classifications (in this case, the domain type) for the existing data, and then using this classification in subsequent searching and display. In this way the tool helps to systematise a large body of data, collapsing multiple cases to representative examples, and guaranteeing an analysis having wide coverage.

6 Conclusion

There are many ways to address the challenges posed by the Dschang data. One can enrich the representation of tones by adopting register tones and tonal root nodes (Snider 1990)—the 'paradigmatic dimension'. One can explore the prosodic structures to which tones are associated, assigning tones to non-terminal nodes and to boundaries or providing alignment constraints (Pierrehumbert and Beckman 1988, Hyman 1990)—the 'syntagmatic dimension'. One can refine and elaborate the system of phonetic interpretation, and parameterise it in various ways (Lieberman et al. 1993, Bird 1994a). The wealth of analytical possibilities—compounded with the sheer difficulty of providing a complete analysis—underscores the value of making large amounts of primary data accessible in paradigm-like form, and making it simpler for researchers to address one another's datasets in a responsible fashion.

In advocating a technological approach, it has not been my intention to argue against the use of impressionistic transcriptions. In fact, the database described here makes heavy use of such transcriptions, and the interface helps

linguists to derive maximum benefit from those transcriptions. Inconsistencies stand out and are discovered at an early stage. Searching transcriptions using numerical sequences avoids the needle-in-a-haystack approach to finding counter-examples, as was neatly illustrated for the L₁HL sequence discussed in section 4.2. Equally, it has not been my intention to argue against the use of pencil and paper for exploring field data. After all, working with a page-size quantity of data at a time is about the most someone can handle without suffering cognitive overload, plus it helps the investigator to see and intuitively grasp complex relationships between forms. Again, the technological approach actually facilitates the pencil-and-paper mode of exploration. The program makes it possible to experiment with a variety of different tabulations of the same data, a useful preliminary step to generating hardcopy tabulations to be analysed away from the computer screen. There are several other advantages. First, it avoids the time-consuming process of producing each new tabulation by hand, for the once-off overhead of entering the data. Second, it avoids the painful process of recopying tabulations in order to rearrange some rows and columns, or substitute new rows and columns, or propagate corrections. Third, it avoids the risk of introducing scribal errors into each new version. Finally, right from the start we are producing layouts that can be reproduced inside physical documents.

In this paper I have argued for a new mode of investigation in linguistic research based on field data, an approach which combines primary description, theoretical analysis, and tool development. I hope to have demonstrated that this synthesis is both possible and desirable, and I hope to have stimulated the production of improved linguistic software and the construction of shared linguistic resources. Putting digitised speech data and transcriptions on the web along with a powerful search tool makes field recordings accessible, transcriptions verifiable, and a large dataset manageable. Articles whose empirical content is too large for journal publication can make the majority of the material available on the web, avoiding the need for extended appendices in the print document (which have to be laboriously retyped by subsequent analysts). Published analyses of data from relatively inaccessible languages can be scrutinised on external grounds without mounting an expedition. Reanalyses are not limited to endless rearrangements of the data contained in an initial description, driven by purely internal arguments about prior analyses. On the contrary, publishing large datasets supports restudies going right back to the empirical foundations, which is crucial in any discipline having multiple paradigms. The success of this methodology will be measured to the extent that others make new observations about the patterning of tone in the data I have reported here, and devise better analyses.

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